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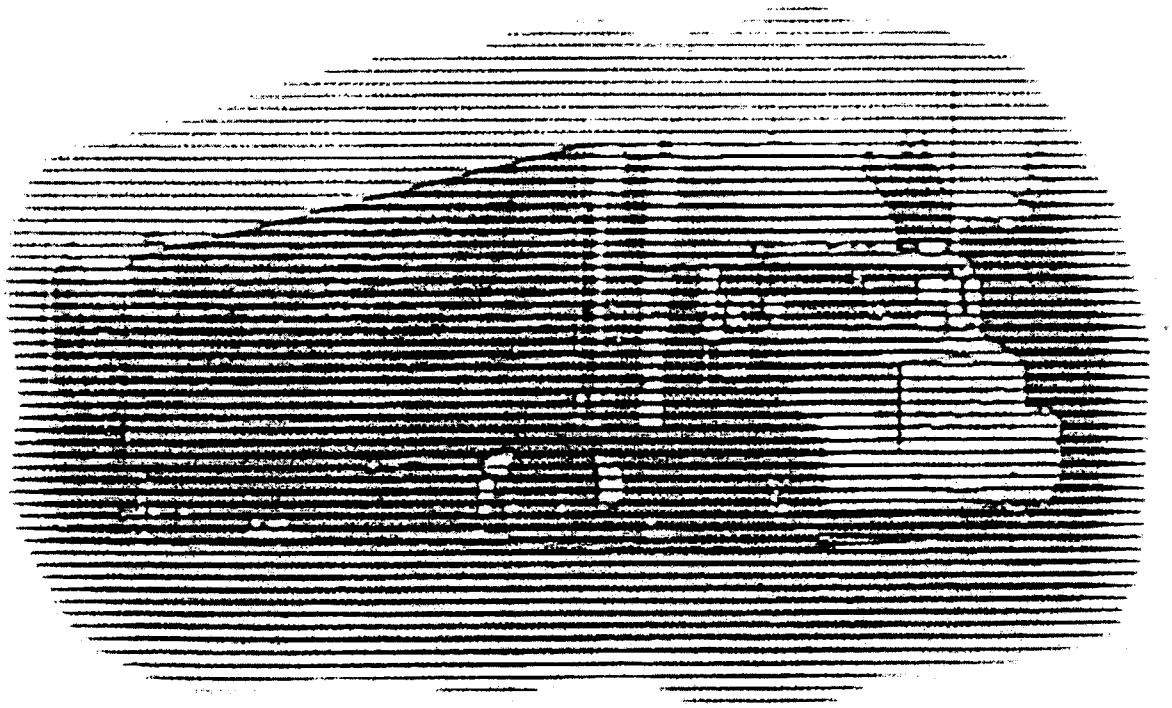
Evaluation of a Truck-Activated Rollover Warning System

A Research Report by
Raminder Bola
Traffic Operations Program

June 1999



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16. ABSTRACT

Truck rollover accidents on urban freeways occur more frequently at highway interchanges, particularly on curved exit ramps, than at any other location. A truck may rollover if the lateral acceleration imposed upon it as it travels around a curve of a certain radius and superelevation is greater than allowable, given its loading condition. This report evaluates a Truck-Activated Rollover Warning System (TARWS). The TARWS uses truck classification technology to theoretically detect and warn truck drivers when their truck speed exceeds the safe operating speed.

A specific site was chosen, in California, because of its high frequency of rollover type accidents. The TARWS was installed and a before/after analysis was conducted to determine the effectiveness of the system. This report provides information on the design, its costs and its cost-effectiveness.

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EVALUATION OF A TRUCK-ACTIVATED ROLLOVER WARNING SYSTEM

Prepared by the

Traffic Operations Program
California Department of Transportation
Business, Transportation and Housing Agency
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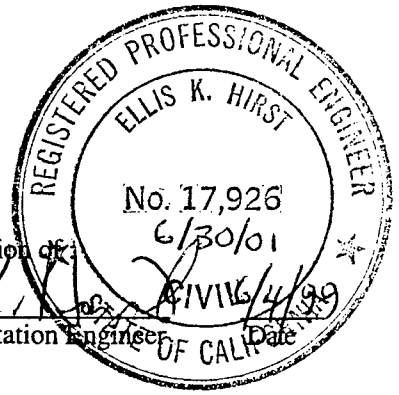
EVALUATION OF A TRUCK-ACTIVATED ROLLOVER WARNING SYSTEM

JUNE 1999



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EXECUTIVE SUMMARY

Truck rollover accidents are a significant highway safety concern, with consequences that make the occurrences important despite their relative infrequency. Truck accidents on urban freeways occur more frequently at highway interchanges, particularly on curved exit ramps, than at any other location on California highways (21). Rebuilding the infrastructure to provide exit ramps with a better safety margin would be very costly, and in many cases would not be possible due to limited right-of-way. This report evaluates a Truck-Activated Rollover Warning System (TARWS). The system theoretically warns drivers when their truck, based on ramp geometry and speed, may rollover if its speed was not reduced. The main objectives of this report are to:

1. Develop a system for a TARWS that measures high approach speeds for potential rollover trucks.

2. Estimate equipment, installation and operational costs for installation of a TARWS at a ramp with a potential for truck rollover accidents.

3. Determine the cost-effectiveness of installing a TARWS at a ramp with a high potential for truck rollover accidents.

A highway ramp with a high number of truck rollover accidents was selected using detailed accident reports produced by the Traffic Accident Surveillance Analysis System (TASAS) maintained by Caltrans. A before and after accident analysis was performed to evaluate the effectiveness of installing the TARWS. The ramp selected was a freeway to freeway connection having a downgrade leading to a small radius curve. The radius of the curve is approximately 175 feet. A truck classification detector system was embedded in the pavement to identify the truck and its relevant parameters. An inductive loop, piezoelectric sensor and inductive loop combination identify the trucks. A model 170E electronic controller accepts the electrical inputs from the detection system, processes the profile according to the logic for identifying a truck that may rollover and then sends a signal to activate the warning device. A static warning sign with two flashing yellow beacons was used to alert truck drivers. The cost for purchase and installation of the TARWS was approximately $50,000.

During the two-year evaluation period, not a single truck rollover accident occurred at the site compared to six accidents during the 6.3 years prior to installation.

Since the TARWS is a combination of existing devices, there are no industry standards for the functions of this system. Because the warning system is a prototype, it is understandable that some maintenance issues needed to be addressed. Those issues are included in chapter five of this report. Despite the required maintenance, the back-up functions worked properly.

It is difficult to assess, with an adequate level of certainty, the cost-effectiveness of a TARWS and how much it reduces the number of accidents. This is due to the low frequency of truck rollover accidents, the short evaluation periods and the small number of tested sites within both California and those that have been the subject of similar studies in other states. Considering the potential of truck rollover accidents, this system appears to yield savings in lives, injury and damage. The savings provided from reduced damage, time delays and clean-up costs also support investing funds in a TARWS. Therefore, the Truck-Activated Rollover Warning System is considered beneficial for reducing the potential for truck rollover accidents on curved ramps and should be a consideration when evaluating a site with a greater than expected number of truck rollover accidents.

CHAPTER 1: INTRODUCTION

1.1 Background

Truck rollover accidents are a significant highway safety concern, with consequences that make the occurrences important despite their relative infrequency. Truck accidents on urban freeways occur more frequently at highway interchanges, particularly on curved exit ramps, than at any other location. Trucks overturning on exit ramps at interchanges account for 5 percent of fatal truck accidents (2). A single rollover accident has the potential to cause millions of dollars of damage because these accidents can result in fatalities and injuries, vehicle and roadway damage, traffic delays and environmental concerns. One example that shows the potential damage due to a single truck rollover accident happened on April 30, 1994 in San Diego County. A tractor-trailer traveling approximately 25 mph on the curved transition from Interstate 8 west to Interstate 5 south rolled over. The tractor-trailer was carrying approximately 7,800 gallons of jet fuel, and spilled approximately 200 gallons onto the landscape of the interchange. The driver of the truck was killed in the accident. Traffic was delayed for a long period at this interchange between the two major freeways due to the hazardous materials cleanup effort. This incident illustrates the variety and magnitude of losses that can be associated with truck rollover accidents.

The maneuvering limits of trucks on ramps are quite low relative to those of automobiles because the geometric requirements of trucks are used to establish maximum design requirements for ramp design (13). This leaves a smaller margin of error for the operation of trucks on ramps. A 1986 Federal Highway Administration (FHWA) analysis of the influence of design features on truck accidents indicated that the American Association of State Highway and Transportation Officials' (AASHTO) policy on geometric design resulted in a smaller margin of error for large trucks on freeway ramps. Problematic features included side friction factors, superelevation transitions, compound curves, ramp downgrades, curbs on curved ramps and wet surface friction on high speed ramps (13). Rebuilding the infrastructure to provide exit ramps with a better safety margin would be very costly, and in many cases would not be possible due to limited right-of-way.

A TARWS could be installed on these ramps, to potentially help truck drivers take preventative action sooner. The system would warn drivers that the truck, based on ramp geometry and speed, may rollover if its speed were not reduced (15). An

advanced detection and warning system for commercial vehicles may reduce the potential for truck rollover accidents.

1.2 Current Treatment

The California Department of Transportation (Caltrans) uses a variety of standard traffic control devices as a means to communicate with drivers and reduce the potential for truck rollover accidents. These standard traffic control devices are specified in chapter four of the Caltrans Traffic Manual (8). Variations include larger than required signs or additional chevrons, additional arrow signs, and/or additional delineators. One example is the W4 sign, shown in Appendix 1, which is a "tipping truck" symbol sign used on ramps or branch connectors which have sharper curvatures, possibly a downgrade, and high approach speeds relative to the safe operating speeds on the subject curve. This sign is only placed where there is a history of trucks overturning. Signs are typically used in combination with advisory speed signs.

1.3 Objective of the Study

The analysis done in this study intended to evaluate the effectiveness of a TARWS. The following are the main objectives of this study:

1. To develop a system for a TARWS when high approach speeds are measured for potential rollover trucks. This will be a combination of existing devices to address the threat of a rollover.

2. To estimate equipment, installation and operational costs for a TARWS at a ramp with a potential for truck rollover accidents.

3. To determine the cost-effectiveness of installing a TARWS at a ramp with a high potential for truck rollover accidents in California.

1.4 Methodology

A highway ramp with a high number of truck rollover accidents was selected using detailed accident records produced by the TASAS database. The accident records retrieved were for the four-year period from 1990 through 1994. Characteristics of the

ramp are summarized in Table 1. In 1996, trucks accounted for 18 percent of the total vehicles using the selected ramp (19). The study assumes that the frequency of accidents is proportional to the traffic volume. It is also assumed that the same factors that affected truck rollovers at the ramp before installation of the warning system, happen after installation. For the purpose of this study the:

Before Period = January 1, 1990 through April 17, 1996 (6.3 years)
After Period = April 18, 1996 through April 17, 1998 (2.0 years)

The findings are based on a comparison of truck rollover accidents 6.3 years before and 2.0 years after operation of the warning system began. Truck Average Annual Daily Traffic (TAADT) on the ramp was analyzed to show the truck volume before and after operation of the warning system. The cost-effectiveness of installing a TARWS was calculated based on accident data determined in this study and estimates of cost per fatality and injury from Caltrans estimated accident costs. The findings of the before and after accident analysis performed in this study are discussed in the following sections.

Table 1: Ramp Characteristics

Characteristic	Southbound Interstate 5 to Eastbound State Route 120
Exit Type	Right-lane exit
Roadway	Curved, freeway to freeway connector ramp
Posted Freeway Speed Limit	Cars: 65 mph Trucks: 55 mph
Posted Ramp Advisory Speed	20 mph
Description	Downgrade leading to a small radius curve.

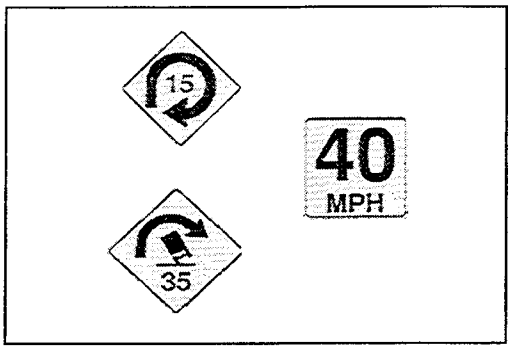
CHAPTER 2: LITERATURE REVIEW

2.1 Literature Search

In 1988 the Center for Applied Research, Incorporated, sponsored by the FHWA, did a study of ramp signing for trucks (13). The study addressed methods for treating interchange ramps that are prone to cause trucks with a high center of gravity to lose control and rollover. A "design-a-sign" study was conducted using professional truck drivers. This study attempted to develop innovative procedures for effectively communicating critical ramp characteristics to approaching drivers.

In the study, a series of laboratory tests were conducted to identify the specific sign elements and formats that most effectively warn truck drivers about potentially dangerous ramps. Two of the lab tests used truck drivers to determine which sign elements, either words or symbols, were most effective. A third lab test, also involved the truck drivers, determined the most effective format of the various sign elements. A fourth lab test, using both truckers and non-truckers, involved meaning and preference testing of the most promising sign formats. The final laboratory test examined the relative visibility of the final sign formats. Again, truckers were used to test the signs. The laboratory tests indicate several different sign formats perform equally well in terms of subject understanding and performance. The test signs that perform best include the following elements (14):

Figure 1: Examples of Signs



- Diagrammatic curve arrow (Caltrans W4 sign)
- Advisory speed sign (Caltrans W6 sign)
- Rear portrait of a tipping truck (Caltrans W4 sign)

The legibility testing strongly supports the use of symbolic signs using the rear portrait of a tipping truck, a dramatic curve arrow and an advisory speed sign (14). The laboratory studies also clearly indicate the desirability of using advance signing located well before the ramp, and the desirability of using flashing lights in

combination with these signs (14). This use of signage is consistent with Caltrans policy and is represented at the site used to test the TARWS.

Another FHWA sponsored demonstration project was done by Bellomo-McGee, Incorporated (BMI). The demonstration project was to install a TARWS in three locations on the Washington, D.C. Beltway. These three sites had previous incidents involving large trucks, and were considered the most vulnerable to rollover type accidents (2).

The systems were installed in 1993 and evaluated independently over a three-year period by BMI. In that project, piezoelectric sensors, inductive loops and optical sensors were used to measure the weight, speed and height of passing vehicles as they approached freeway ramps. Based on those parameters, trucks were identified and classified by the local controller (computer), and separated on the basis of height (greater or less than 11 feet high) into "box" or "tanker" truck respectively. Speed was measured at two points, allowing longitudinal acceleration to be estimated. The speed during the turn was then projected, allowing lateral acceleration in the turn to be estimated. If the estimated lateral acceleration was higher than a preset rollover threshold for the identified class and type of vehicle, warning lights on a roadside sign were turned on until the vehicle had passed the sign (18). The study provides a description of the operation of the three sites. The final report, released in March 1997, presented the findings of the evaluation.

One of the findings of the evaluation was that the activation of the sign was related to greater speed reduction. The findings showed that the overall speed reduction of trucks when the warning systems were activated is 21.7 percent higher than those trucks using the ramps when the warning systems were not activated. The report concludes that the TARWS caused truck speed reductions at each of the sites (6).

A second and more significant finding of the evaluation was the overall effectiveness of the system. The three sites chosen for testing the system were selected because of their previous history of experiencing truck rollover accidents. One site chosen had experienced 6 rollover accidents in five years while the two other sites had experienced 2 rollover accidents in four years. A three-year evaluation of the systems showed that not a single accident of this type occurred after the warning systems were installed. The study theorized that there would approximately be a 35 percent reduction in

rollover accidents at the selected sites (16). It was concluded that the systems have successfully contributed to a safer roadway for truck drivers, other motorists and surrounding residents. In addition to improving safety, they have also provided a good return on the funds invested by the savings provided from reduced property damage, vehicle damage, time delays and clean-up costs (6).

CHAPTER 3: THE RAMP AND THE WARNING SYSTEM

3.1 The Site

The TARWS was installed in San Joaquin County on a connector ramp located at postmile 14.736 on southbound Interstate 5. This single lane ramp selected connects to eastbound State Route 120. The posted advisory ramp speed is 20 mph. The ramp is on a downgrade leading to a short radius curve. The radius of the curve is approximately 175 feet. A plan view along with TARWS dimensions and approximate curve data of the site are located in Figure 3. A long downgrade ramp, coupled with a short radius curve, as suggested by a FHWA report on the relationship between truck accidents and geometric design (9), can cause rollovers to occur due to gravitation and vehicle acceleration. Since this site provides a connection from one freeway to another, the tendency of truckers to accelerate to speeds greater than the advisory speed sign posted in anticipation of merging on to another freeway may contribute to rollover accidents at this site. The actual accident rate at this location is higher than the average accident rate for similar locations in the state highway network. Of the reported accidents since 1990, six were truck rollovers.

Figure 2: The Site

Figure 3: Plan View of TARWS

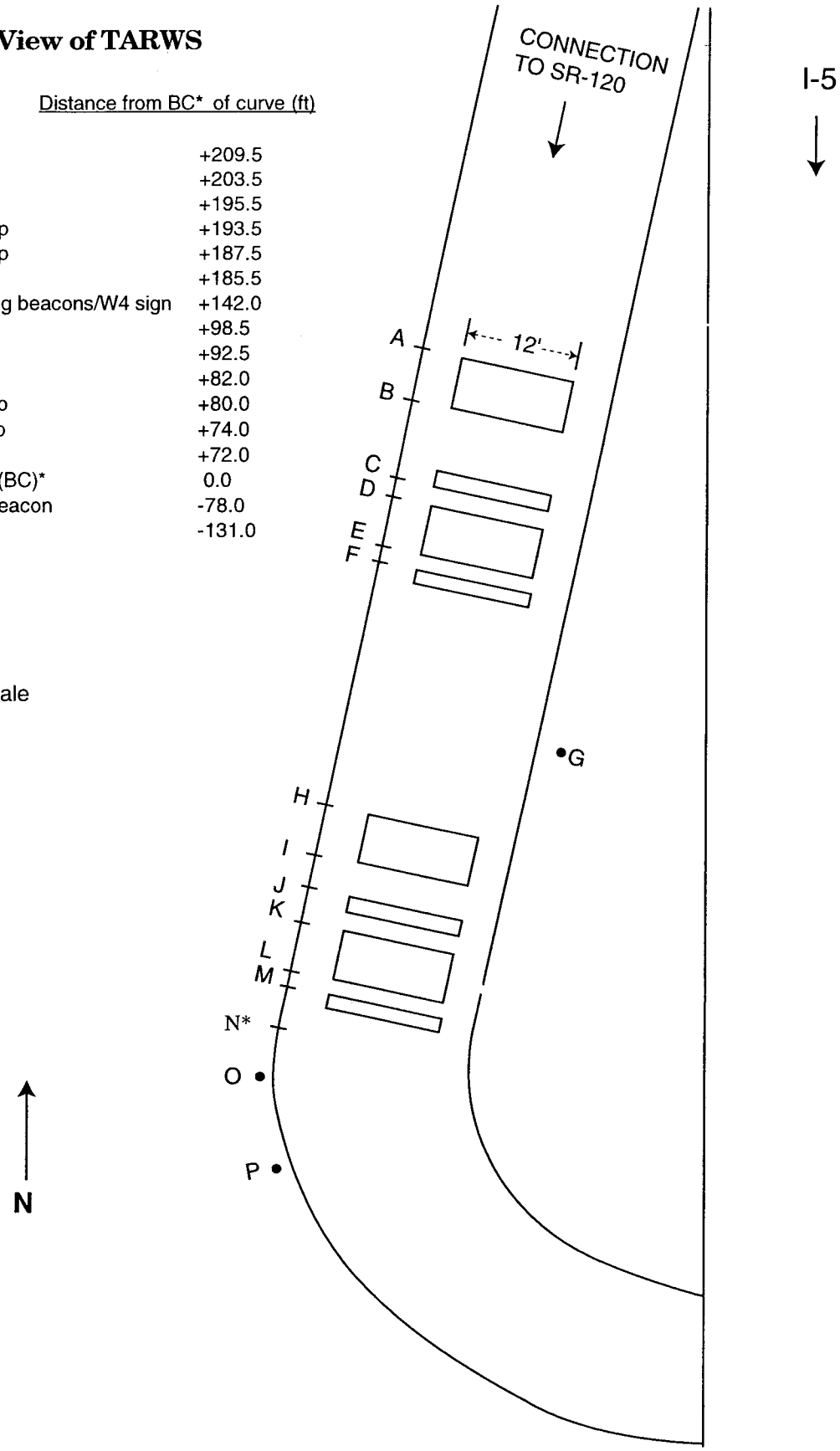
TARWS Component	Distance from BC* of curve (ft)
A. Front of first loop	+209.5
B. Back of first loop	+203.5
C. First piezo	+195.5
D. Front of second loop	+193.5
E. Back of second loop	+187.5
F. Second piezo	+185.5
G. Two 120 volt flashing beacons/W4 sign	+142.0
H. Front of first loop	+98.5
I. Back of first loop	+92.5
J. First piezo	+82.0
K. Front of second loop	+80.0
L. Back of second loop	+74.0
M. Second piezo	+72.0
N. Beginning of curve (BC)*	0.0
O. Auxiliary flashing beacon	-78.0
P. Controller cabinet	-131.0

Curve Data

Radius ≈ 175 ft

Length ≈ 800 ft

• Drawing is not to scale



3.2 The Detection System

A truck classification detector system was embedded in the ramp to identify the vehicle and its relevant parameters. The parameters identified were speed and the vehicle type such as truck or non-truck. The detector system consists of an inductive loop, piezoelectric sensor and inductive loop combination. The inductive loops create a magnetic field which turns the system on and off by sending signals to the controller when a truck travels over the first and second loops respectively. Using the same signals and an amount of time elapsed over a pre-determined distance, the controller calculates the speed of the truck. Piezoelectric sensors are embedded in the pavement between the two inductive loops. The piezoelectric sensors are sensitive to pressure caused by the passing of tires which produces a voltage profile. The voltage profile is used to determine the number of axles and axle spacing. This information allows the controller to match the voltage profile to an existing profile database to classify the truck type.

3.3 The Controller

The model 170E electronic controller accepts the electrical inputs from the detection system, processes the profile according to the logic for identifying a truck that may rollover and then sends a signal to activate the warning device. The sensors give the controller enough information to determine a safe speed for the vehicle to negotiate the exit ramp based on ramp geometry. The vehicle type, ramp gradient, curve radius and curve superelevation are all considered in the calculation of the maximum safe speed for that truck. If a truck's speed is greater than its calculated maximum safe speed, the controller operates the flashing beacons. The controller will send a signal to stop the flashing beacons at a set time after the truck has cleared the sensors. If a malfunction occurs, the controller will continuously flash the beacons until the problem is fixed. The controller is housed in an aluminum cabinet. The electricity to run the controller is drawn from a nearby power source.

3.4 The Warning Device

A static warning sign with two flashing yellow beacons is used to alert drivers. These flashing beacons are designed to direct the drivers attention to the message of the warning sign. The sign is a standard Caltrans static truck rollover warning sign (W4) and two flashing yellow beacons, which would be activated by the controller if the system detects a truck traveling at a speed greater than its safe operating speed. The safe operating speed is the maximum speed at which a particular truck can have

while traversing the ramp. Once the truck clears the sensors, the controller will turn off the flashing beacons after a preset period.

3.5 Cost

The cost for purchase and installation of the TARWS was approximately $50,000. This included loop-piezoelectric-loop sensors, a control unit, a control cabinet, two flashing beacons and a warning sign.

CHAPTER 4: RESULTS OF THE STUDY

4.1 Results

Operation of the TARWS began on April 18, 1996. Truck rollover accidents for before and after April 18, 1996 are tabulated in Table 2. See Appendix 2 for the TASAS accident reports which contain details about each accident which occurred at the site during the before and after evaluation periods.

Table 2: Comparison of Before and After Truck Rollover Accidents

	Before Installation (6.3 years)	After Installation (2 years)
Number of Accidents	6	0
Number of Accidents/Year	0.95	0.00

Before Period = January 1, 1990 through April 17, 1996 (6.3 years)
After Period = April 18, 1996 through April 17, 1998 (2.0 years)

The equivalent two year rollover accident frequency for the before period:

$$\frac{(6 \text{ accidents} \times 2 \text{ years})}{6.3 \text{ years}} = 1.9 \text{ accidents}$$

The Truck Average Annual Daily Traffic (TAADT) of the ramp is:

Before Period = 7759 trucks
After Period = 9154 trucks

The traffic volumes are used to calculate the Traffic Volume Correction Factor:

$$\text{Traffic Volume Correction Factor} = \frac{9154 \text{ trucks}}{7759 \text{ trucks}} = 1.18$$

Assuming that there is a linear relationship between accidents and the TAADT, the number of accidents from the equivalent two-year before period rollover accident

frequency is adjusted by the Traffic Volume Correction Factor for comparison with the number of accidents during the after period:

1.9 accidents x 1.18 = 2.2 accidents

Therefore the truck rollover accident frequency for the before period at the site is 2.2 truck rollover accidents in two years. The installation of the TARWS did produce a reduction in truck rollover accidents, but the number of accidents were too few for the difference to be statistically significant. Since there was not a truck rollover accident at the site after installing the TARWS, it could be concluded that some of the safety improvement can be attributed to the installed device.

4.2 Benefit/Cost Analysis

Compared to the high cost involved in changing the geometry of an existing curved ramp, the TARWS is a low price alternative. This one-lane system cost approximately $50,000, which includes purchase and installation. Based on the BMI study, the cost to maintain the system for ten years is estimated to be $1,000 per year (2). Using an interest rate of 5 percent, the net present value for the cost of this system with a ten-year life expectancy is $57,722.

The benefits from a TARWS are a reduction in truck rollover accidents and in the associated costs. These costs are the dollar values assigned to the fatalities, injuries, property damage, cargo loss, possible damage to the highway facility, motorist delays, traffic control and cleanup costs incurred by the accident. Truck accidents are even more costly when an environmental spill of fuels, chemicals or hazardous cargo is involved. Accident costs will only be used to evaluate the potential benefits of the TARWS, but it is understood that by avoiding accidents, other associated costs will not materialize. The economic values Caltrans assigns to accident costs[1] on highways, intersections and ramps are shown (7):

Fatality = $850,000
Injury = $17,200
PDO = $3,700

[1] Accident costs include direct out-of-pocket costs, medical treatment, and loss of earnings. The assignment of a cost to fatal accidents is not an attempt to assign a monetary value to life. No attempt is made to evaluate the worth of a life to the individual or their family or to assign monetary value to pain, suffering, and sorrow.

Given the results of the two years of operation, a TARWS, if installed at critical locations, could prevent at least two accidents every two years. Table 3 shows the required truck rollover accident reductions needed for the warning system to be cost effective. A cost-effectiveness calculation for Property Damage Only (PDO) accidents was not conducted because it is assumed that truck rollover accidents cost more than the economic value Caltrans assigns to PDO accidents.

TABLE 3: REQUIRED ACCIDENT REDUCTION FOR TARWS COST-EFFECTIVENESS

Type of Accident	Accident Cost ($)	Number of rollover accidents that need to be eliminated by the TARWS in a ten-year period. (TARWS cost = $57,722)
Fatal	850,000	0.07
Injury	17,200	3.36

Comparing the truck rollover accident frequency of 2.2 accidents every two years to the figures in Table 3 reveals the cost-effectiveness of the TARWS. The system would be cost-effective if applied at ramps with a high frequency of truck rollover accidents. If the system prevents just one fatal accident or four injury accidents in ten years, the system would pay for itself. This result is consistent with results from a similar system in the BMI report whose system would be cost-effective by eliminating 0.13 fatal or 6.3 injury accidents in a ten-year period (15).

The cost of the TARWS was approximately $50,000. Of the six truck rollover accidents which occurred at the site during the 6.3 year before period, three resulted in injuries while the other three resulted in PDO. This yields an average of one PDO and one injury truck rollover accident every two years. Since a single truck rollover accident has not occurred during the two year after period, the TARWS has given an estimated savings of $20,900. This is almost half of the initial cost of the system in only two years.

The previously referenced study by BMI included a cost analysis for a TARWS (2). The analysis revealed that if the average truck rollover accident was to result in $100,000 of economic loss, then the elimination of 2 accidents in ten years would more than pay for their single lane system. Referring back to Table 2, there were six rollover accidents at this one ramp in a 6.3 period. If an average rollover accident was to result in $100,000 of economic loss, it appears reasonable that an effective TARWS could be cost-effective if applied at ramps with a history of truck rollover accidents of at least

one every ten years. Based on the prior study and this study, it appears that a TARWS improves safety. However, conclusive statements cannot be made due to the small number of accidents in the analysis.

4.3 Accident Reduction Factor

A preliminary Accident Reduction Factor (ARF) is recommended for this device on California state highways. Development of a more precise ARF based on accident data is advisable at this time due to the low frequency of truck rollover accidents, the short evaluation period and the small number of tested sites within California. However, based on the result of this study, findings of other research studies described in this report and engineering judgement, it is recommended that the current reduction factor of 20 percent for a ten-year life used for Flashing Beacons (20) be used for the TARWS. The ARF will be updated as more such devices are installed and as more accident data is available.

CHAPTER 5: DISCUSSION AND RECOMMENDATIONS

5.1 Discussion

The TARWS is currently running on a back-up system. The flashing beacons are continuously flashing due to a damaged inductive loop. An auxiliary flashing beacon was added to the system to supply an additional warning device. The location of the auxiliary flashing beacon relative to the TARWS system is shown on Figure 3. Adding the auxiliary beacon provided truck drivers with additional time to see the truck rollover warning sign and lower their speed. The system initially had problems with the piezoelectric axle sensor due to traffic noise problems affecting the signal to the controller. This was caused by having too great a distance between the sensor and the controller unit (a distance of 326.5 feet). A special piezoelectric amplifier/repeater was used to improve the signal received from the sensor. During the winter of 1997, the ramp was closed for six to eight weeks due to flooding. No recorded damage occurred to the warning system.

Since the TARWS is a combination of existing devices, there are no industry standards for the functions of this system. Because the warning system is a prototype, it is understandable that some maintenance issues still need to be addressed. Despite required maintenance, the TARWS back-up functions worked properly. The continuously flashing beacons focus the drivers' attention on the speed warning sign that informs speeding truck drivers to lower their speed in order to maneuver the curve.

Although the TARWS has had maintenance problems, data indicates that the device does appear to have a positive effect on the number of truck rollover accidents. This is consistent with the findings of other reports reviewed within the literature search. The reports confirmed the advisability of current Caltrans practice of installing the type W4 signs, and indicates that at locations where flashing beacons were installed to accompany the signs, a corresponding reduction in truck rollover accidents should occur. With further studies and analysis, TARWS could be applied to any situation where overturning is a problem, such as conventional highways in mountainous terrain.

5.2 Conclusion

The decrease in rollover accidents reflects not only the effect of the TARWS, but it may also reflect the effect of factors such as weather, driver behavior, a non-linear relationship between accidents and traffic volume, and other factors. It can be inferred from the results of the reports noted in the literature search that warning signs for truck rollovers when accompanied by flashing beacons make a difference in truck speeds and should lead to a corresponding reduction in truck rollover accidents. It is likely that a considerable portion of the observed reduction in accidents is attributable to the continuously flashing beacons. Based on the BMI report, the installation of the TARWS may also have a positive effect on truck rollovers

Because of the low frequency of truck rollover accidents at freeway ramps, it is difficult to assess, with an adequate level of certainty, the cost-effectiveness of the system and how much it reduces the number of accidents. A more reliable assessment could be achieved if the system were to be installed at several locations and/or if the evaluation period was longer.

Due to unforeseen maintenance issues, this report was unable to determine if a TARWS is more effective than continuously flashing beacons. Based on the BMI study, it can be inferred that a TARWS enhances the capability of the warning devices by directing the warning to specific trucks that have the greatest potential to rollover.

Considering the potential of truck rollover accidents to have resultant fatal accidents, injury accidents or related environmental damage with delays for the traveling public, this system appears to have the potential to yield considerable savings in life, injury and damage. The TARWS appears to provide a good return on the funds invested by the savings provided from reduced damage, time delays and clean-up costs. Therefore, the Truck-Activated Rollover Warning System is considered beneficial and worthy of further testing for preventing truck rollover accidents on curved ramps. Once additional systems are installed, supplemental studies could prove this conclusion.

5.3 Recommendation

Theoretically, the TARWS is supposed to be a more effective system than the flashing beacons in reducing the number of truck rollover accidents. During the majority of the two-year after period, the TARWS operated on the continuous flashing back-up

system due to the previously discussed malfunctions. The Accident Reduction Factor used for flashing beacons based on our Highway Safety Improvement Guidelines is 20 percent. The ARF for the TARWS is assumed to be the conservative value of 20 percent based on the accident analysis described in this report, the findings of other studies discussed in the literature search and engineering judgement. At curved ramps with a significant potential for truck rollover accidents, it is recommended to install continuous flashing beacons along with existing curve warning and speed signs. This would be considered the first phase in mitigating truck rollover problems at a particular ramp. If truck rollovers continue to occur, then a second phase of mitigation would be appropriate after the site is reviewed by Headquarters and District traffic engineers using the guidelines in Appendix 4. The second phase would be to install a TARWS at the ramp. However, as illustrated in this study, a TARWS may have maintenance problems. A warranty should be included in the construction contract and a service contract should be purchased to support the equipment after installation. A properly working TARWS should cost-effectively reduce the number of truck rollover accidents. Additionally it is recommended that an effort to develop a standard plan for the installation of this device as a routine safety improvement be considered to facilitate the ease of design and that an ARF of 20 percent be assigned to this device[2]. The devices should be considered for installation on ramps that experience greater than expected number of truck rollover accidents, and evaluated as to their effectiveness as a part of the Highway Safety Improvement Program. The effectiveness of the system should be reevaluated after a period of five years.

[2] The Accident Reduction Factor should not be used in all cases. The study of accident histories at individual locations sometimes indicates that higher, or lower reduction factors are more appropriate. In such cases, Headquarters approval is required.

REFERENCES

1) American Association of State Highway and Transportation Officials: A Policy on Geometric Design of Highways and Streets. Washington, DC, 1994.

2) Bareket, Z., P. Francher, W. Hughes, S. Joshua, H. McGee, and R. Strickland. Feasibility of an Automatic Truck Warning System. FHWA-RD-93-039, Federal Highway Administration, McLean, VA, September 1993: 1.

3) Barnes, M., R. Ervin, C. MacAdam, and R. Scott. Impact of Specific Geometric Features on Truck Operations and Safety At Interchanges. FHWA/RD-86/057, Federal Highway Administration, McLean, VA, August 1986.

4) Barnes, M.A., R.D. Ervin, and C.C. MacAdam. "Influence of the Geometric Design of Highway Ramps on the Stability and Control of Heavy-Duty Trucks." Symposium on Geometric Design for Large Trucks. Transportation Research Board, National Research Council, Washington, DC 1986.

5) Barnes, M.A., R.D. Ervin, and C.C. MacAdam. "Truck Control Problems Posed by the Design of Highway Ramps." Vehicle Highway Infrastructure: Safety Compatibility. Society of Automotive Engineers, Inc., Warrendale, PA, February 1987.

6) Bergan, Arthur T., Robert J. Bushman, and Brian Taylor. Intelligent Truck Rollover Advisory Systems. Department of Civil Engineering, Saskatoon, Saskatchewan, Canada: 5.

7) California Department of Transportation. Accident Data on California State Highways. Sacramento, CA, 1994: 85.

8) California Department of Transportation. Traffic Manual. Sacramento, CA, 1996: 17.

9) Davis, S., P. Hu, S.P. Miaou, A. Rathi, and T. Wright. Development of Relationship Between Truck Accidents and Geometric Design: Phase I. FHWA-RD-91-124, Federal Highway Administration, McLean, VA, March 1993: 17.

10) Ervin, Robert D. "Effects of Expressway Ramps on Control of Tractor-Semitrailers." The UMTRI Research Review. January-February 1986:10.

11) Ervin, Robert D. and Bennett E. Stone. Survey of the Trucking Industry's Preferences for IVHS. IVHS Technical Report-90-4, University of Michigan Transportation Research Institute, Ann Arbor, MI, October 1990.

12) Fancher, Paul S. and Thomas D. Gillespie. Truck Operating Characteristics. NCHRP Synthesis 241, National Cooperative Highway Research Program, Washington, DC, 1997.

13) Freedman, Mark, Paul L. Olson, and Paul L. Zador. Speed Actuated Rollover Advisory Signs for Trucks on Highway Exit Ramps. University of Michigan Transportation Research Institute, Ann Arbor, MI, December 1992: 4.

14) Knoblauch, Richard L. and Marsha Nitzburg. Ramp Signing for Trucks. FHWA-RD-91-042, Federal Highway Administration, McLean, VA, March 1993: 53.

15) McGee, Hugh W., and Rodney R. Strickland. "An Automatic Warning System to Prevent Truck Rollover on Curved Ramps." Public Roads. (Spring 1994: 1): On-line. Internet. August 9, 1998.

16) McGee, Hugh W. and Rodney R. Strickland. Evaluation Results of Three Prototype Automatic Truck Rollover Warning Systems. Bellomo McGee, Inc. Vienna, VA.

17) Nelligan, Bruce and Sany R. Zein. "Identifying Optimal Locations for the Deployment of a Truck Rollover Warning System." Advances in Intelligent Transportation System Design. SP-1285, Society of Automotive Engineers, Inc., Warrendale, PA, August 1997.

18) Richards, Stephen H., and Scott Stevens. Condition Responsive Truck Rollover Warning Systems: Alternative System Designs. Oak Ridge National Laboratory, Oak Ridge, TN, October 1997: 4.

19) California Department of Transportation. 1996 Annual Average Daily Truck Traffic on the California State Highway System. Sacramento, CA, 1996: 19.

20) California Department of Transportation. Traffic Safety Index Program. Sacramento, CA, April 1992: 33.

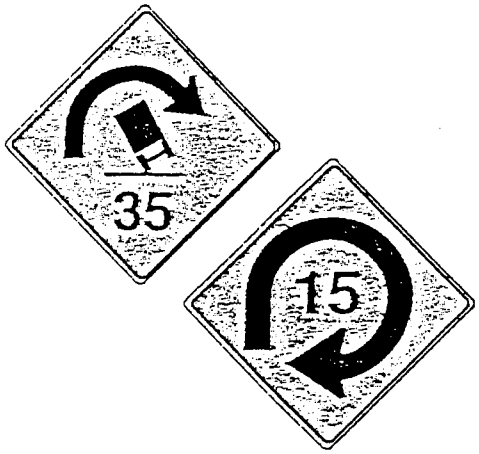
21) Khorashadi, Ahmad. Effect of Ramp Type and Geometry on Accidents. California Department of Transportation. Sacramento, CA, November 1998: 3.

Appendix A

Diagram and Description of the Caltrans W4 Sign

POLICY

W4



SPECIAL CURVE /TURN ARROW AND ADVISORY SPEED SIGNS

The Special Curve/Turn Arrow and Advisory Speed signs (W4) may be used at problem locations in the head-on position where the standard curve or turn signs have not proven to be effective. Existing pavement markings should also be evaluated.

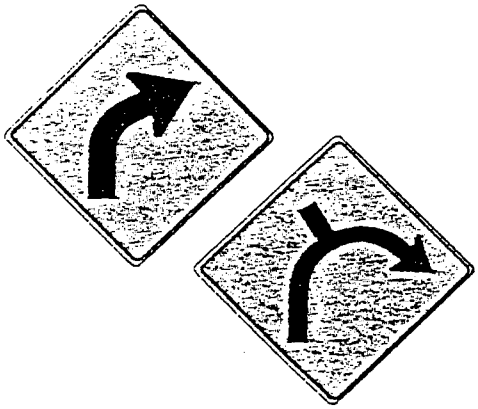
Existing advance warning signs should be left in place when the W4 sign is erected.

The advisory speed shall be determined in accordance with Section 4-02.4.

CURVE SIGN

W5

W1-2



The Curve sign (W5) should be used in advance of curves where the advisory speed is 56 km/h (signed as 35 MPH) or greater. This sign may be ordered for either right curves or left curves. The Advisory speed plate (W6) should be used below this sign.

For advisory speeds of 48 km/h (signed as 30 MPH) or less, the Turn sign (W3) shall be used.

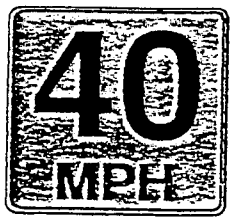
The advisory speed shall be determined in accordance Section 4-02.4.

See the W14 for policy on the use of curve warning signs in mountainous terrain.

ADVISORY SPEED PLATE

W6

W13-1



The Advisory Speed plate (W6) should be used to supplement curve and turn warning signs. The speed shown shall be a multiple of 5 MPH and shall not be in excess of the posted or maximum speed limit. The advisory speed shall be determined in accordance with Section 4-02.4.

The Advisory Speed plate (W6) may also be used with other warning signs where an engineering analysis determines that the conditions indicate the need for a significant reduction in speed. The typical conditions where an advisory speed may be considered are: "Pavement Ends", "Narrow Road Lane/Lanes", "Rough Road", "Loose Gravel", "Road Narrows", "One Lane Bridge", "Bump", "Dip", etc..

The Advisory Speed Plate shall not be used in conjunction with any sign other than a warning sign, nor shall it be used alone. When used, it shall be positioned below the warning sign.

Appendix B

Traffic Accident Surveillance Analysis System (TASAS) Records

ACCIDENT CODE DEFINITIONS

ACCIDENT SUMMARY FIELDS

[5|0|1] DISTRICT (2)
01 to 12

[5|0|2] ROUTE (4)
999#

COUNTY (3)
XXX - Use County Abbrv.

[5|0|6] PM (7)
#000000

DATE (6)
MMDDYY

[1|1|0] SEVERITY (1)
F - Fatal
I - Injury
P - Property Damage Only

[1|2|0] ACCIDENT TIME (4)
HHMM 24 Hour Clock

[5|0|8] FILE TYPE (1) FT
H - Highway
I - Intersection
R - Ramp

[5|1|0] HOUR OF DAY (2)
00 - 12Mid.
01 - 1 A.M.
02 - 2 A.M.
03 - 3 A.M.
04 - 4 A.M.
05 - 5 A.M.
06 - 6 A.M.
07 - 7 A.M.
08 - 8 A.M.
09 - 9 A.M.
10 - 10 A.M.
11 - 11 A.M.
12 - 12Noon
13 - 1 P.M.
14 - 2 P.M.
15 - 3 P.M.
16 - 4 P.M.
17 - 5 P.M.
18 - 6 P.M.
19 - 7 P.M.
20 - 8 P.M.
21 - 9 P.M.
22 - 10 P.M.
23 - 11 P.M.
25 - Unknown

[5|1|4] SIDE OF HIGHWAY (1) SOH
N - Northbound
S - Southbound
E - Eastbound
W - Westbound

[5|1|5] INTRS/RAMP ACC LOC (1) ERL
1 - Ramp Intersection (Exit)
2 - Ramp
3 - Ramp Entry
4 - Ramp Area, Intersect Street
5 - In Intersection
6 - Outside Intrs -Nonstate Rte.
- - Does Not Apply

[5|1|7] COMMON ACC NO. (9)
CII Number -Officers Badge No.

[5|1|8] REPORTING LEVEL (1)
1 - Below Reporting Level
2 - Above Reporting Level
< - Not Stated or Undetermined

[5|1|9] PRIMARY COLL FACTOR (1) PCF
1 - Influence of Alcohol
2 - Following Too Close
3 - Failure to Yield
4 - Improper Turn
5 - Speeding
6 - Other Violation
8 - Improper Driving
C - Other Than Driver
D - Unknown
E - Fell Asleep (7-1-87)
< - Not Stated

[5|2|0] DAY OF WEEK (1)
1 - Sunday
2 - Monday
3 - Tuesday
4 - Wednesday
5 - Thursday
6 - Friday
7 - Saturday

[5|2|1] WEATHER (1) W
A - Clear
B - Cloudy
C - Raining
D - Snowing
E - Fog
F - Other
< - Not Stated

[5|2|2] LIGHTING (1) L
A - Daylight
B - Dusk/Dawn
C - Dark - Street Light
D - Dark - No Street Light
E - Dark - Inopr Street Light
F - Dark - Not Stated
< - Not Stated

[5|2|3] ROAD SURFACE (1) S
A - Dry
B - Wet
C - Snow, Icy
D - Slippery
< - Not Stated

[5|2|4] ROADWAY CONDITION (1) RC
A - Holes, Ruts
B - Loose Material
C - Obstruction on Road
D - Construction - Repair Zone
E - Reduced Road Width
F - Flooded
G - Other
H - No Unusual Condition
< - Not Stated

[5|2|5] RIGHT OF WAY CONTROL (1) RWC
A - Control Functioning
B - Control Not Functioning
C - Controls Obscured
D - No Controls Present
< - Not Stated

[5|2|6] TYPE OF COLLISION (1) TOC
A - Head-On
B - Sideswipe
C - Rear End
D - Broadside
E - Hit Object
F - Overturn
G - Auto-Pedestrian
H - Other
< - Not Stated

[5|2|7] NO. MOTOR VEH. INVOLVED (2)
01 TO 99

PARTY SUMMARY FIELDS

0 = Examine all Parties Present
1 - 9 = Examine only Specified Party No.

[6|0] PARTY TYPE (1) PT
A - Pasngr Car/Sta Wagon
B - Pasngr Car w/trailer
C - Motorcycle
D - Pickup/Panel Truck
E - Pickup/Panel w/Trailer
F - Truck, Truck Tractor
G - Trk/Tractor w/Trailer
2 - Trk/Trac w/2 Trailers ②
3 - Trk/Trac w/3 Trailers ②
4 - Single Unit Tanker ③
5 - Trk/Trac w/1 Tank Trair ③
6 - Trk/Trac w/2 Tank Trair ③
H - School Bus
I - Other Bus
J - Emergency Vehicle
K - Highway Const. Equip.
L - Bicycle
M - Other Vehicle ①
N - Other Non-Vehicle ①
O - Spilled Load
P - Disengaged Tow
Q - Uninvolved Vehicle
R - Moped
T - Train
U - Pedestrian
V - Dismounted Pedestrian
W - Animal-Livestock
X - Animal-Deer
Z - Animal-Other PTR

[6|1] DIRECTION TRAVEL (1)
N - Northbound
S - Southbound
E - Eastbound
W - Westbound
< - Not Stated
- - Does Not Apply

[6|2] VEH. HWY. INDICATOR (1)
1 - On State Route
2 - Not on State Route
3 - Intersecting State Route
< - Not Stated
- - Does Not Apply

[6|4] PERSONS KILLED (2)

[6|5] PERSONS INJURED (2)
00 - 99

[6|6] PRIMARY OBJ STRUCK (2) OSP/OSO

[6|8] OTHER
01 - Side of Bridge Railing
02 - End of Bridge Railing
03 - Pier, Column, Abutment
04 - Bottom of Structure
05 - Bridge End Posts in Gore
06 - End of Guard Rail
07 - Bridge Approach Grd Rail
10 - Light or Signal Pole
11 - Utility Pole
12 - Pole (Type Not Stated)
13 - Traffic Sign/Sign Post
14 - Other Signs Not Traffic
15 - Guardrail
16 - Median Barrier
17 - Wall (exc. Soundwall)
18 - Dike or Curb
19 - Traffic Island
20 - Raised Bars
21 - Concrete Object (HDWL, D.I.)
22 - Guidepost, Culvert, PM
23 - Cut Slope or Embankment
24 - Over Embankment
25 - In Water
26 - Drainage Ditch
27 - Fence
28 - Trees
29 - Plants
30 - Sound Walls
40 - Natural Material on Road
41 - Temp Barricades, Cones, Etc.
42 - Other Object on Road
43 - Other Object off Road
44 - Overturned
45 - Crash Cushions
98 - Unknown Object Involved
99 - No Object Involved
VI - Thru V9 - Vehicle 1 to 9
<< - Not Stated
-- - Does Not Apply

[6|3] SPECIAL INFO (1) SI
A - Hazardous Mtls (since 7-1-82)
B - Vehicle Fire (7-1-82/6-30-87)
C - Tire Defect/Failure (7-1-82/6-30-87)
< - Not Stated
- - Does Not Apply

[6|7] PRIMARY LOC OF COLL (1) LOC

[6|9] OTHER
A - Beyond Median or Stripe - Left (NE-2LN)
B - Beyond Shldr Drivers Left
C - Left Shoulder Area
D - Left Lane
E - Interior Lanes
F - Right Lane
G - Right Shoulder Area
H - Beyond Shldr Drivers Right
I - Gore Area
J - Other
< - Not Stated
- - Does Not Apply OA

[7|4] 1ST OTHER ASSOC FACTOR (1)

[7|5] 2ND
1 - Influence of Alcohol
2 - Following Too Close
3 - Failure to Yield
4 - Improper Turn
5 - Speeding
6 - Other Violations
E - Vision Obscurement
F - Inattention
G - Stop & Go Traffic
H - Enter/Leave Ramp
I - Previous Collision
J - Unfamiliar with Road
K - Defective Veh. Equipment
L - Uninvolved Vehicle
M - Other
N - None Apparent
P - Wind
R - Ramp Accident
S - Runaway Vehicle
< - Not Stated
- - Does Not Apply MOV

[7|6] MOVE PRECEDING COLL (1)
A - Stopped
B - Proceeding Straight
C - Ran off Road
D - Making Right Turn
E - Making Left Turn
F - Making U-Turn
G - Backing
H - Slowing, Stopping
I - Pass Other Vehicle (2Wy-2Ln)
J - Change Lanes
K - Parking
L - Enter From Shoulder
M - Other Unsafe Turn
N - Cross into Opposing Lane (Undiv. Only)
O - Parked
P - Merging
Q - Traveling Wrong Way
R - Other
< - Not Stated
- - Does Not Apply

PEDESTRIAN
2 - Xing Xwalk - Intersection
3 - Xing Xwalk - Not Intersection
4 - Xing not Xwalk
5 - Roadway-Include Shoulder
6 - Not in Roadway
7 - Approach/Leave School Bus

[7|7] 1ST SOBRIETY (1) SD

[7|8] 2ND (DRUG/PHYSICAL) (1)
A - Had Not Been Drinking (0%)
B - HBD - Under Influence (>0.08)
C - HBD - Not Under Influence (0.01-0.07)
D - HBD - Impairment Unknown
E - Under Drug Influence
F - Other Physical Impairment
G - Impairment Unknown
H - Not Applicable
I - Driver Fatigue
< - Not Stated
- - Does Not Apply

① After 7/1/89, Before Both M
② After 1/1/85, Before Combined W/G
③ After 7/1/87, Before Combined W/F, G & 2

AXR253-A 10-19-98

TASAS TABLE 9 DISTRICT 13
SELECTIVE ACCIDENT RATE CALCULATION
ROUTE SEQUENCE

PAGE

LOCATION DESCRIPTION	RA GRP (RUS)	NUMBER OF ACCIDENTS/SIGNIFICANCE* TOT	FAT	INJ	MULTI F+I	MULTI VEH	WET	DARK	PER NIGHT	ADT MAIN X-ST	TOTAL MV+ OR MVM	ACCIDENT RATE ACCS/MV+ OR MVM-* ACTUAL FAT	ACTUAL F+I	ACTUAL TOT	AVERAGE FAT	AVERAGE F+I	AVERAGE TOT
005 SJ R 14.736 SB OFF TO EB ROUTE 120 10-0001 90-01-01 96-04-18 76 MO	R05 R99	3	0	3	3	1	2	2	0	3.2	7.28+	.000	.41	1.78	.008	.23	.70

+ DENOTES MV USED IN RATES

REQ NO	DIST	RTES NO	RTES U F	CO	P R E LOC POST MILE	I F T	S R L	O H	D A Y	ACCIDENT DATE MO DA YR	TIME HHMM	COMMON ACCIDENT NUMBER	P C F	ENVIR COND W L S	R C C	R W C	T O C	NO MTR VEH	P T R	D I	V H I	S I	PERSN K	PERSN I	O S P	L O C	O S O	L O C	O S O	L O C	O S O	L O C	OA F 12	M O V	SD P 12
0001	10	005		SJ	R014.736	R	2	S	4	01-10-90	0835	926509717	5	E A B	H	A	E	01	G	S	1	<	00	01	15H		44G		---		---		N<	C	A<
0001	10	005		SJ	R014.736	R	2	S	7	09-22-90	1605	926504693	5	A A A	H	D	E	01	R	<	1	<	00	00	---		99G		---		---		<<	R	<<
																			G	S	1	<	00	00	15H		---		---		---		F<	C	A<
0001	10	005		SJ	R014.736	R	2	S	6	11-02-90	1500	926505841	C	A A A	H	A	E	01	O	<	1	<	00	00	---		99F		---		---		<<	R	<<
																			3	S	1	<	00	00	---		---		---		---		6<	B	A<
0001	10	005		SJ	R014.736	R	3	S	5	04-18-91	1415	926511335	5	A A A	C	D	E	02	O	<	1	<	00	00	15H		---		---		---		<<	R	<<
																			A	S	1	<	00	00	42E		---		---		---		F<	B	A<
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0001	10	005		SJ	R014.736	R	2	S	4	06-19-91	0730	926509361	5	A A A	H	D	E	01	G	S	1	<	00	00	15H		44H		---		---		F<	C	A<
0001	10	005		SJ	R014.736	R	2	S	3	02-25-92	1100	926508193	6	A A A	H	D	H	01	G	S	1	<	00	00	---		---		---		---		K<	B	A<
																			P	S	1	<	00	00	44F		---		---		---		<<	B	<<
																			O	<	1	<	00	00	---		15H		---		---		<<	R	<<
0001	10	005		SJ	R014.736	R	2	S	5	05-21-92	1315	926511342	5	A A A	H	D	E	01	M	S	1	<	00	00	18B		44B		---		---		N<	[illegible]	A<
0001	10	005		SJ	R014.736	R	2	S	4	07-29-92	1040	926509361	5	A A A	H	A	F	01	G	S	-	<	00	01	44F		15H		13H		---		4<	C	A<
0001	10	005		SJ	R014.736	R	2	S	5	08-20-92	1150	926510313	5	A A A	H	A	E	01	2	S	-	<	00	01	15H		44F		---		---		4<	C	A<
0001	10	005		SJ	R014.736	R	2	S	1	10-03-93	0645	926508175	4	A D A	H	D	E	01	A	E	-	<	00	00	15H		18B		24B		---		N<	C	A<
0001	10	005		SJ	R014.736	R	2	S	2	10-04-93	0740	926508905	5	B A A	H	D	E	01	A	E	-	<	00	00	15H		---		---		---		F<	[illegible]	A<
0001	10	005		SJ	R014.736	R	2	S	3	01-11-94	0145	926511335	E	E D A	H	D	F	01	G	E	1	<	00	00	44B		---		---		---		4<	[illegible]	A<
0001	10	005		SJ	R014.736	R	2	S	1	12-04-94	1630	926511202	5	B A B	H	A	F	01	D	S	1	<	00	00	44B		24B		---		---		N<	C	C<

LOCATION DESCRIPTION	RA GRP (RUS)	*-NUMBER OF ACCIDENTS/SIGNIFICANCE* TOT	FAT	INJ	MULTI F+I	VEH	WET	DARK	PER KLD INJ	*ADT * MAIN X-ST	TOTAL MV+ OR MVM	*-ACCIDENT RATE ACCS/MV+ OR MVM-* ACTUAL FAT	F+I	TOT	AVERAGE FAT	F+I	TOT
005 SJ R 14.736 SB OFF TO EB ROUTE 120 10-0001 96-04-18 98-04-18 24 MO	R05 (R)	3	0	2 H90	2	0	0	1	1 2	2.7	1.97+	.000	1.01	1.52	.008	.23	.70

+ DENOTES MV USED IN RATES

\XR261

TABLE 3 ACCIDENT RECORDS

10-19-98 PAGE 1

REQ NO	DIST	RTES NO	RTES U F	CO	P R E	LOC POST MILE	F T	I R L	S O H	D A Y	ACCIDENT DATE MO DA YR	TIME HHMM	COMMON ACCIDENT NUMBER	P C F	ENVIR COND W	L	S	R C	R W C	T O C	NO MTR VEH	P T	D I R	V H I	S I	PERSN K	PERSN I	O L S Q P C	O L S O O C	O L S O O C	O L S O O C	OA F 12	M O V	SD P 12
0001	10	005		SJ	R	014.736	R	2	S	1	11-03-96	0407	926513647	1	E	C	A	H	D	E	01	A	S	1	<	00	01	18H	44B	24B	26B	4<	C	3<
0001	10	005		SJ	R	014.736	R	2	S	6	02-21-97	1005	926509361	4	A	A	A	H	D	E	01	A	S	1	<	00	00	15H	13H	---	---	5<	C	A<
0001	10	005		SJ	R	014.736	R	2	S	1	09-14-97	0915	926509277	C	A	A	D	G	A	E	01	D	S	1	<	00	01	18B	24B	44B	---	N<	C	A<

Appendix C

Project Specifications and Plans for the Truck-Activated Rollover Warning System (TARWS) in District 10, San Joaquin County, Postmile 14.736, Southbound Interstate 5 to Eastbound State Route 120.

OBM-1501

STATE OF CALIFORNIA

DEPARTMENT OF TRANSPORTATION

DISTRICT 10

Notice to Contractors No. 10E076

NOTICE TO CONTRACTORS
AND
SPECIAL PROVISIONS

Sealed proposals for the work shown on the plans entitled:

STATE OF CALIFORNIA; DEPARTMENT OF TRANSPORTATION; PROJECT PLANS FOR CONSTRUCTION ON STATE HIGHWAY IN SAN JOAQUIN COUNTY ABOUT 9 MILES SOUTH OF STOCKTON FROM BEGIN SAN JOAQUIN RIVER BRIDGE TO 0.1 MILE EAST OF END SAN JOAQUIN RIVER BRIDGE

will be received by the Department of Transportation, at the District office building, 1976 E. Charter Way, Stockton, California 95205 by no later than 1:30 p.m., June 21, 1995, at which time they will be publicly opened and read in the Business Management Office.

General work description: Truck warning system.

At the time bids are opened the successful bidder must possess either a Class A license or a Class C-10 license.

The Department of Transportation reserves the right to reject any or all bids.

The foregoing is a general description of the work to be performed and the Department of Transportation does not expressly or by implication agree that the actual items or amount of work will correspond therewith.

Further inquiries concerning the proposed work may be directed to the Department of Transportation, Don Mattes, Minor Contracts Section, Room 2 NW, 1976 E. Charter Way, P.O. Box 2048, Stockton, CA 95201, Phone (209) 948-7325.

For information on bids and contracts: Ken Peters, Business Management Branch, Phone (209) 948-7231.

For a bid package or plan holder list, fax your request to: (209) 948-7774; or telephone (209) 948-3820.

For bid results, phone (209) 942-6001 after 2:30 p.m. the day of bid opening.

SECTION 1. SPECIFICATIONS AND PLANS

1-1.01 GENERAL.--The work embraced herein constitutes a "Minor Contract". The work shall be done in accordance with the July, 1992 Standard Specifications, the July, 1992 Standard Plans of the Department of Transportation, the special provisions for Minor B construction contracts, the proposed "Form of Contract," and the attached project plans.

All references to the Director in the July, 1992 Standard Specifications shall be construed to mean the District Director.

Any paragraph of the Standard Specifications referencing or pertaining to Chapter 1 (commencing with Section 10100) of Part 2 of Division 2 of the Public Contract Code shall not apply to this contract.

In the event of conflict between the Standard Specifications and these special provisions, the special provisions shall take precedence over and be used in lieu of such conflicting portions.

1-1.02 PROJECT PLANS.--Project plans consist of 3 sheets of plans.

1-1.03 STANDARD PLANS.-- Standard Plan sheets from Standard Plans of the State of California Department of Transportation dated July, 1992 applicable to this contract include, but are not limited to, the following:

A10A, A10B, T1, T2, T3, T10, T14, RS2, ES-1A, ES-1B, ES-2A, ES-2C, ES-3A, ES-3C, ES-8, ES-13.

SECTION 2. PROPOSAL REQUIREMENTS AND CONDITIONS

2-1.01 GENERAL.--Attention is directed to the provisions in Section 2, "Proposal Requirements and Conditions," of the Standard Specifications and these special provisions for the requirements and conditions which must be observed in the preparation of the proposal form and the submission of the bid.

In addition to the subcontractors required to be listed in accordance with Section 2-1.054, "Required Listing of Proposed Subcontractors," of the Standard Specifications, each proposal shall have listed therein the name and address of each MBE, WBE and DVBE subcontractor to be used for credit in meeting the goals, and to whom the bidder proposes to directly subcontract portions of the work. The list of subcontractors shall also set forth the portion of work that will be done by each subcontractor listed. A sheet for listing the subcontractors is included in the Notice to Contractors and Special Provisions.

2-1.02 BIDS.--Bids are to be submitted for the entire work. The amount of the bid for comparison purposes will be the total for all items.

The bidder shall set forth for each unit basis item of work a unit price and a total for the item, and for each lump sum item a total for the item, all in clearly legible figures in the respective spaces provided for that purpose. In the case of unit basis items, the amount set forth under the "Item Total" column shall be the product of the unit price bid and the estimated quantity for the item.

In case of discrepancy between the unit price and the total set forth for a unit basis item, the unit price shall prevail, except as provided in (a) or (b), as follows:

(a) If the amount set forth as a unit price is unreadable or otherwise unclear, or is omitted, or is the same as the amount as the entry in the item total column, then the amount set forth in the item total column for the item shall prevail and shall be divided by the estimated quantity for the item and the price thus obtained shall be the unit price;

(b) (Decimal Errors) If the product of the entered unit price and the estimated quantity is exactly off by a factor of ten, one hundred, etc., or one-tenth, or one-hundredth, etc. from the entered total, the discrepancy will be resolved by using the entered unit price or item total, whichever most closely approximates percentage wise the unit price or item total in the Department's Final Estimate of cost.

If both the unit price and the item total are unreadable or otherwise unclear, or are omitted, the bid may be deemed irregular. Likewise if the item total for a lump sum item is unreadable or

otherwise unclear, or is omitted, the bid may be deemed irregular unless the project being bid has only a single item and a clear, readable total bid is provided.

Symbols such as commas and dollar signs will be ignored and have no mathematical significance in establishing any unit price or item total or lump sums. Written unit prices, item totals and lump sums will be interpreted according to the number of digits and, if applicable, decimal placement. Cents symbols also have no significance in establishing any unit price or item total since all such figures are assumed to be expressed in dollars and/or decimal fractions of a dollar. Bids on lump sum items shall be item totals only; if any unit price for a lump sum item is included in a bid and it differs from the item total, the items total shall prevail.

The foregoing provisions for the resolution of specific irregularities cannot be so comprehensive as to cover every omission, inconsistency, error or other irregularity which may occur in a bid. Any situation not specifically provided for will be determined in the discretion of the Department, and such discretion will be exercised in the manner deemed by the Department to best protect the public interest in the prompt and economical completion of the work. The decision of the Department respecting the amount of a bid, or the existence or treatment of an irregularity in a bid, shall be final.

2-1.025 BLANK.

2-1.027 MBE/WBE/DVBE GOALS FOR THIS PROJECT.--The Department has established no goals for Minority Business Enterprise (MBE), Women Business Enterprise (WBE) and Disabled Veteran Business Enterprise (DVBE) participation for this project:

2-1.03 CALIFORNIA COMPANY PREFERENCE.--Attention is directed to Section 3-1.04, "Award and Execution of Contract," of these special provisions.

In accordance with the requirements of Section 6107 of the Public Contract Code, a "California company" will be granted a reciprocal preference for bid comparison purposes as against a nonresident contractor from any state that gives or requires a preference to be given contractors from that state on its public entity construction contracts.

A "California company" means a sole proprietorship, partnership, joint venture, corporation, or other business entity that was a licensed California contractor on the date when bids for the public contract were opened and meets one of the following:

(1) Has its principal place of business in California.

(2) Has its principal place of business in a state in which there is no local contractor preference on construction contracts.

(3) Has its principal place of business in a state in which there is a local contractor construction preference and the contractor has paid not less than $5,000 in sales or use taxes to California for construction related activity for each of the five years immediately preceding the submission of the bid.

To carry out the "California company" reciprocal preference requirements of Section 6107 of the Public Contract Code, all bidders shall fill out and sign the California Company Preference form in the Proposal. The bidder's signature on the California Company Preference form certifies, under penalty of perjury, that the bidder is or is not a "California company" and if not, the amount of the preference applied by the state of the non-California company.

Proposals without the California Company Preference form filled out and signed may be rejected.

2-1.04 PROPOSAL GUARANTY.--Section 2-1.07, "Proposal Guaranty," of the Standard Specifications is amended to read:

All bids shall be presented under sealed cover and if the bid amount is more than $5,000 the bid shall be accompanied by one of the following forms of bidder's security:

Cash, a cashier's check, a certified check, or a bidder's bond executed by an admitted surety insurer, made payable to the Director of Transportation.

The security shall be in an amount equal to at least 10 percent of the amount bid. A bid will not be considered unless one of the forms of bidder's security is enclosed with it. The bidder's bond shall conform to the bond form included in the bid proposal.

2-1.05 BLANK.

2-1.06 SMALL BUSINESS PREFERENCE.--Attention is directed to "Award and Execution of Contract" of these special provisions.

Attention is also directed to the Small Business Procurement and Contract Act, Government Code Section 14835, et seq., and Title 2, California Code of Regulations, Section 1896, et seq.

Bidders who wish to be classified as a Small Business under the provisions of said laws and regulations, shall be certified as a small business by the Department of General Services, Small and Minority Business, 1531 "I" Street, Second Floor, Sacramento, CA 95814.

To request Small Business Preference, bidders shall fill out and sign the Request for Small Business Preference form in the Proposal, and shall attach a copy of their Office of Small and Minority Business (OSMB) small business certification letter to the form. The bidder's signature on the Request for Small Business Preference certifies, under penalty of perjury, that the bidder is certified as Small Business by the time of bid openingand further certifies, under penalty of perjury, that under the following conditions, at least 50 percent of the subcontractors to be utilized on the project are either certified Small Business or have applied for Small Business certification by bid opening date and are subsequently granted Small Business certification.

The conditions requiring the aforementioned 50 percent level of subcontracting by Small Business subcontractors apply if:

1. The lowest responsible bid for the project exceeds $100,000; and
2. The project work to be performed requires a Class A or a Class B contractor's license; and
3. Two or more subcontractors will be used.

If the above conditions apply and Small Business Preference is granted in the award of the contract, the 50 percent Small Business subcontractor utilization level shall be maintained throughout the life of the contract.

2-1.07 PROPOSAL FORMS.--The first sentence of the second paragraph of Section 2-1.05, "Proposal Forms," of the Standard Specifications is amended to read:

The proposal form is attached to the Notice to Contractors and Special Provisions.

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2-1.08 LICENSED CONTRACTOR-STANDARDS FOR QUALITY OF WORK.--Licensed contractors must observe professional standards for quality of work or the California Contractors' State License Board will invoke disciplinary action.

Notice is hereby given that certain actions by a contractor, including, but not limited to the following, constitute grounds for disciplinary action once the State has notified the license board of all violations:

1. A willful departure from plans and specifications or disregard of trade standards for good and workmanlike construction in any material respect that might prejudice the Department of Transportation, owner of the property upon which you perform work (Bus. & Prof. Code, § 7109).
2. The failure to observe and comply with all of the applicable labor laws (Bus. & Prof. Code, § 7110).
3. Material failure to complete this contract (Bus. & Prof. Code, § 7113).

Should the State determine that the work or materials provided vary materially from the specifications, or, that defective work when completed was not performed in a workmanlike manner, then the Contractor warrants that he shall perform all necessary repairs, replacement and corrections needed to restore the property according to the contract plans and specifications, all at no further or additional cost to the State.

SECTION 3. SUBMISSION OF MBE/WBE/DVBE INFORMATION AND AWARD AND EXECUTION OF CONTRACT

3-1.01 BLANK.

3-1.01A BLANK.

3-1.02 BLANK.

3-1.03 CONTRACT BONDS.--In the event the total amount of the contract is more than $5,000, the successful bidder shall furnish the 2 bonds specified in Section 3-1.02, "Contract Bonds", of the Standard Specifications.

3-1.04 AWARD AND EXECUTION OF CONTRACT.--The award of contract, if it be awarded, will be to the lowest responsible bidder whose proposal complies with all the requirements prescribed and who has met the goals for MBE/WBE/DVBE participation or has demonstrated, to the satisfaction of the Department, good faith effort to do so. Meeting the goals for MBE/WBE/DVBE participation or demonstrating, to the satisfaction of the Department, good faith efforts to do so is a condition for being eligible for award of contract. Attention is directed to the provisions in Section 2-1.03 "California Company Preference" of these special provisions.

The amount of the California company reciprocal preference shall be equal to the amount of the preference applied by the state of the nonresident contractor with the lowest responsive bid, except where the "California company" is eligible for a California Small Business Preference, in which case the preference applied shall be the greater of the two, but not both.

If the bidder submitting the lowest responsive bid is not a "California company" and with the benefit of the reciprocal preference, a "California company's" responsive bid is equal to or less than the original lowest responsive bid, the "California company" will be awarded the contract at its submitted bid price except as provided below.

Small business bidders shall have precedence over nonsmall business bidders in that the application of the "California company" preference for which nonsmall business bidders may be eligible shall not result in the denial of the award to a small business bidder.

A "Vendor Data Record" form will be included in the contract documents to be executed by the successful bidder. The purpose of the form is to facilitate the collection of taxpayer identification data. The form shall be completed and returned to the Department by the successful bidder with the executed contract and contract bonds. For the purposes of the form, vendor shall be deemed to mean the successful bidder. The form is not to be completed for subcontractors or suppliers. Failure to complete and return the "Vendor Data Record" form to the Department as provided herein will result in the retention of 31 percent of payments due the contractor and penalties of up

to $20,000. This retention of payments for failure to complete the "Vendor Data Record" form is in addition to any other retention of payments due the Contractor.

Attention is directed to "Small Business Preference" of these special provisions. Any bidder who is certified as a small business by the Department of General Services, Office of Small and Minority Business will be allowed a preference in the award of this contract, if it be awarded, under the following conditions:

(1) The apparent low bidder is not certified as a small business; and
(2) The bidder filled out and signed the Request for Small Business Preference form included with documents.

The small business preference will be a reduction in the bid submitted by the small business contractor, for bid comparison purposes, by an amount equal to 5 percent of the amount bid by the apparent low bidder. If such reduction results in the small business contractor becoming the low bidder, then the contract will be awarded to said small business contractor on the basis of the actual bid of the small business contractor notwithstanding the reduced bid price used for bid comparison purposes.

3-1.05 FAILURE TO EXECUTE CONTRACT.--Section 3-1.04, "Failure to Execute Contract," of the Standard Specifications shall not apply to contracts, where the bid amount is $5,000 or less.

SECTION 4. BEGINNING OF WORK, TIME OF COMPLETION AND LIQUIDATED DAMAGES

4-1.01 GENERAL.--Attention is directed to Section 8-1.03, "Beginning of Work," Section 8-1.06, "Time of Completion," and Section 8-1.07, "Liquidated Damages," of the Standard Specifications and these special provisions.

4-1.01A BEGINNING OF WORK.--The first paragraph of Section 8-1.03, "Beginning of Work," of the Standard Specifications is amended to read:

The Contractor shall begin work within 15 calendar days after the contract has been approved by the District Contract Officer authorized to represent the Department of Transportation.

Said work shall be diligently prosecuted to completion before the expiration of

20 WORKING DAYS

beginning on the fifteenth calendar day after approval of the contract.

The first sentence of the second paragraph of Section 8-1.03, "Beginning of Work," of the Standard Specifications is amended to read:

The Contractor shall notify: John Kennedy,
Construction Office Engineer
1976 East Charter Way, P. O. Box 2048
Stockton, CA 95201 Phone (209) 948-7849

at least 72 hours in advance of starting work.

4-1.01B TIME OF COMPLETION AND LIQUIDATED DAMAGES.--The Contractor shall pay the State of California the sum of $250 per day for each and every calendar day of delay in completion of work in excess of the number of working days stipulated above.

In addition to any penalties prescribed herein, should the Contractor fail to commence work within five (5) working days after notification of the starting date, or suspend work for a period of five (5) continuous working days after work has begun, the State may provide five (5) days written notice, posted at the job site or mailed to the Contractor, to timely prosecute and complete the work or the contract may be terminated and liquidated damages of $500.00 assessed for administrative costs for rebidding the work.

In addition, the Contractor shall be liable to the State for the difference between the Contractor's bid price and the actual cost of performing the work by the second low bidder or by another contractor.

4-1.02 TIME RESTRICTIONS.--No work will be permitted on Saturdays, Sundays, or designated legal holidays unless permission is given in writing by the Engineer.

Designated legal holidays are: January 1, the third Monday in February, the last Monday in May, July 4, the first Monday in September, November 11, Thanksgiving Day and December 25. When a designated legal holiday falls on a Sunday, the following Monday shall be a designated legal holiday. When November 11 falls on a Saturday, the preceding Friday shall be a designated legal holiday.

4-1.03 COORDINATION.--The Contractor shall coordinate his schedule of work with the Engineer. The Engineer shall be notified at least 24 hours in advance of any changes in the schedule of work.

SECTION 5. GENERAL

SECTION 5-1. MISCELLANEOUS

5-1.01 LABOR NONDISCRIMINATION.--Attention is directed to the following Notice that is required by Chapter 5 of Division 4 of Title 2, California Code of Regulations.

NOTICE OF REQUIREMENT FOR NONDISCRIMINATION PROGRAM (GOV. CODE, SECTION 12990)

Your attention is directed to the "Nondiscrimination Clause", set forth in Section 7-1.01A(4), "Labor Nondiscrimination," of the Standard Specifications, which is applicable to all nonexempt state contracts and subcontracts, and to the "Standard California Nondiscrimination Construction Contract Specifications" set forth therein. The Specifications are applicable to all nonexempt state construction contracts and subcontracts of $5,000 or more.

5-1.011 ARBITRATION.--The last paragraph in Section 9-1.10, "Arbitration," of the Standard Specifications is amended to read:

Arbitration shall be initiated by a Complaint in Arbitration made in compliance with the requirements of said regulations. A Complaint in Arbitration by the Contractor shall be made not later than 180 days after the date of service in person or by mail on the Contractor of the final written decision by the Department on the claim.

5-1.012 NOTICE OF POTENTIAL CLAIM.--Section 9-1.04, "Notice of Potential Claim," of the Standard Specifications is amended to read:

9-1.04 Notice of Potential Claim.--The Contractor shall not be entitled to the payment of any additional compensation for any act, or failure to act, by the Engineer, including failure or refusal to issue a change order, or for the happening of any event, thing, occurrence, or other cause, unless he shall have given the Engineer due written notice of potential claim as hereinafter specified. Compliance with this Section 9-1.04 shall not be a prerequisite as to matters within the scope of the protest provisions in Section 4-1.03, "Changes," or Section 8-1.06, "Time of Completion," or the notice provisions in Section 5-1.116, "Differing Site Conditions," or Section 8-1.07, "Liquidated Damages," or Section 8-1.10, "Utility and Non-Highway Facilities," nor to any claim which is based on differences in measurements or errors of computation as to contract quantities.

The written notice of potential claim shall be submitted to the Engineer prior to the time that the Contractor performs the work giving rise to the potential claim for additional compensation, if based on an act or failure to act by the Engineer, or in all other cases within 15 days after the happening of the event, thing, occurrence, or other cause, giving rise to the potential claim.

The written notice of potential claim shall be submitted on Form CEM-6201 furnished by the Department and shall be certified with reference to the California False Claims Act, Government Code Sections 12650 - 12655. The notice shall set forth the reasons for which the Contractor believes additional compensation will or may be due and the nature of the costs involved. Unless the amount of the potential claim has been stated in the written notice, the Contractor shall, within 15 days of submitting said notice, furnish an estimate of the cost of the affected work and impacts, if any, on project completion. Said estimate of costs may be changed or updated by the Contractor when conditions have changed. When the affected work is completed, the Contractor shall submit substantiation of his actual costs. Failure to do so shall be sufficient cause for denial of any claim subsequently filed on the basis of said notice of potential claim.

It is the intention of this Section 9-1.04 that differences between the parties arising under and by virtue of the contract be brought to the attention of the Engineer at the earliest possible time in order that such matters may be settled, if possible, or other appropriate action promptly taken. The Contractor hereby agrees that he shall have no right to additional compensation for any claim that may be based on any such act, failure to act, event, thing or occurrence for which no written notice of potential claim as herein required was filed.

Should the Contractor, in connection with or subsequent to the assertion of a potential claim, request inspection and copying of documents or records in the possession of the Department that pertain to the potential claim, Contractor shall make its records of the project, as deemed by the Department to be pertinent to the potential claim, available to the Department for inspection and copying.

5-1.02 WORKERS' COMPENSATION.--Section 7-1.01A(6), "Workers' Compensation," of the Standard Specifications is amended to read:

By my signature on this contract, as Contractor, I certify that I am aware of the provisions of Section 3700 of the Labor Code which require every employer to be insured against liability for workers' compensation or to undertake self-insurance in accordance with the provisions of that code, and I will comply with such provisions before commencing the performance of the work of this contract.

5-1.03 PREVAILING WAGE.--The last sentence of the second paragraph of Section 7-1.01A(2), "Prevailing Wage," of the Standard Specifications is amended to read:

The Index of General Prevailing Wage Rates for this contract is attached to the "Notice to Contractors and Special Provisions".

5-1.04 PREVAILING WAGES NOT REQUIRED.--Payment of prevailing wages is not required if this contract is for:

(a) $25,000 or less for public works construction project.
(b) $15,000 or less for the alteration, demolition, repair or maintenance of public works project.

5-1.05 PAYROLL RECORDS.--Paragraph 13 in Section 7-1.01A(3), "Payroll Records," of the Standard Specifications is amended to read:

If by the time the Engineer receives a bill for work performed under the contract, the Contractor has not submitted satisfactory certified payroll records for the work performed, the Department will withhold all payments due and owing the Contractor pending receipt of such records. Payroll records are not to be submitted if prevailing wages are not required as outlined in Section 5-1.04 of these special provisions.

5-1.055 REVISED RECORDS RETENTION CLAUSE.--For the purpose of determining compliance with Public Contract Code Section 10115, et. seq. and Title 21, California Code of Regulations, Chapter 21, Section 2500 et. seq., when applicable, and other matters connected with the performance of the contract pursuant to Government Code Section 8546.7, the Contractor, subcontractors and the State shall maintain all books, documents, papers, accounting records, and other evidence pertaining to the performance of the contract, including but not limited to, the costs of administering the contract. All parties shall make such materials available at their respective offices at all reasonable times during the contract period for three years from the date of final payment under the contract. The State, the State Auditor, FHWA, or any duly authorized representative of the Federal government shall have access to any books, records, and documents of the Contractor that are pertinent to the contract for audits, examinations, excerpts, and transactions, and copies thereof shall be furnished if requested.

5-1.06 PUBLIC SAFETY.--The Contractor shall provide for the safety of traffic and the public in accordance with the provisions in Section 7-1.09, "Public Safety," of the Standard Specifications and these special provisions.

The Contractor shall install temporary railing (Type K) between any lane carrying public traffic and any excavation, obstacle, or storage area when the following conditions exist:

(1) Excavations.--Any excavation, the near edge of which is 12 feet or less from the edge of the lane, except:

(a) Excavations covered with sheet steel or concrete covers of adequate thickness to prevent accidental entry by traffic or the public.
(b) Excavations less than one foot deep.
(c) Trenches less than one foot wide for irrigation pipe or electrical conduit, or excavations less than one foot in diameter.
(d) Excavations parallel to the lane for the purpose of pavement widening or reconstruction.
(e) Excavations in side slopes, where the slope is steeper than 4:1.
(f) Excavations protected by existing barrier or railing.

(2) Temporarily Unprotected Permanent Obstacles.--Whenever the work includes the installation of a fixed obstacle together with a protective system, such as a sign structure together with protective railing, and the Contractor elects to install the obstacle prior to installing the protective system; or whenever the Contractor, for his convenience and with permission of the Engineer, removes a portion of an existing protective railing at an obstacle and does not replace such railing complete in place during the same day.

(3) Storage Areas.--Whenever material or equipment is stored within 12 feet of the lane and such storage is not otherwise prohibited by the specifications.

The approach end of temporary railing (Type K), installed in accordance with the requirements in this section "Public Safety" and in Section 7-1.09, "Public Safety," of the Standard Specifications shall be offset a minimum of 15 feet from the edge of the traffic lane open to public traffic. The temporary railing shall be installed on a skew toward the edge of the traffic lane of not more than one foot transversely to 10 feet longitudinally with respect to the edge of the traffic lane. If the 15-foot minimum offset cannot be achieved, the temporary railing shall be installed on the 10 to 1 skew to obtain the maximum available offset between the approach end of the railing and the edge of the traffic lane, and an array of temporary crash cushion modules shall be installed at the approach end of the temporary railing.

Temporary railing (Type K) shall conform to the provisions in Section 12-3.08, "Temporary Railing (Type K)" of the Standard Specifications, except temporary railing (Type K) fabricated prior to January 1, 1993, with one longitudinal No. 5 reinforcing steel bar near the top in lieu of the 2 longitudinal No. 5 reinforcing steel bars near the top, as shown on the plans, may be used.

Temporary crash cushion modules shall conform to the provisions in "Temporary Crash Cushion Module" elsewhere in these special provisions.

Except for installing, maintaining and removing traffic control devices, whenever work is performed or equipment is operated in the following work areas the Contractor shall close the adjacent traffic lane unless otherwise provided in the specifications:

Approach speed of public traffic (Posted Limit) (Miles Per Hour)	Work Areas
Over 45	Within 6 feet of a traffic lane but not on a traffic lane.
35 to 45	Within 3 feet of a traffic lane but not on a traffic lane.

The lane closure provisions of this section shall not apply if the work area is protected by permanent or temporary railing or barrier.

When traffic cones or delineators are used to delineate a temporary edge of traffic lane, the line of cones or delineators shall be considered to be the edge of traffic lane, however, the Contractor shall not reduce the width of an existing lane to less than 10 feet without written approval from the Engineer.

When work is not in progress on a trench or other excavation that required closure of an adjacent lane, the traffic cones or portable delineators used for the lane closure shall be placed off of and adjacent to the edge of the traveled way. The spacing of the cones or delineators shall be not more than the spacing used for the lane closure.

Suspended loads or equipment shall not be moved nor positioned over public traffic or pedestrians.

Full compensation for conforming to the requirements in this section "Public Safety," including furnishing and installing temporary railing (Type K) and temporary crash cushion modules, shall be considered as included in the contract prices paid for the various items of work involved and no additional compensation will be allowed therefor.

5-1.065 TEMPORARY CRASH CUSHION MODULE.--This work shall consist of furnishing, installing and maintaining sand filled temporary crash cushion modules in groupings or arrays at each location shown on the plans, specified in the special provisions or directed by the Engineer. The grouping or array of sand filled modules shall form a complete sand filled temporary crash cushion in accordance with the details shown on the plans and these special provisions.

Attention is directed to "Public Safety" of these special provisions.

GENERAL.--Whenever the work or the Contractor's operations establishes a fixed obstacle, the exposed fixed obstacle shall be protected with a sand filled temporary crash cushion. The sand filled temporary crash cushion shall be in place prior to opening the lanes adjacent to the fixed obstacle to public traffic.

Sand filled temporary crash cushions shall be maintained in place at each location, including times when work is not actively in progress. Sand filled temporary crash cushions may be removed during a work period for access to the work provided that the exposed fixed obstacle is 15 feet or more from a lane carrying public traffic and the temporary crash cushion is reset to protect the obstacle prior to the end of the work period in which the fixed obstacle was exposed. When no longer required, as determined by the Engineer, sand filled temporary crash cushions shall be removed from the site of the work.

MATERIALS.--At the Contractor's option, the modules for use in sand filled temporary crash cushions shall be either of the following types or equal:

Energite Inertial Modules

Manufacturer:

Energy Absorption Systems, Inc.
One East Wacker Drive
Chicago, IL 60601-2076
Telephone (312) 467-6750

Distributor(Northern):

Traffic Control Service, Inc.
8585 Thys Court
Sacramento, CA 95828
Telephone (800) 884-8274
FAX (916) 387-9734

Distributor(Southern):

Traffic Control Service, Inc.
1881 Betmor Lane
Anaheim, CA 92805
Telephone (800) 222-8274

or Fitch Inertial Modules

National Distributor:

Roadway Safety Service, Inc.
700-3 Union Parkway
Ronkonkoma, NY 11779

Distributor:

Singletree Sales Company
1533 Berger Drive
San Jose, CA 95112
Telephone (800) 822-7735

Modules contained in each temporary crash cushion shall be of the same type at each location. The color of the modules shall be the standard yellow color as furnished by the vendor, with black lids. The modules shall exhibit good workmanship free from structural flaws and objectionable surface defects. The modules need not be new. Good used undamaged modules conforming to color and quality of the types specified above may be utilized. If used Fitch modules requiring a seal are furnished, the top edge of the seal shall be securely fastened to the wall of the module by a continuous strip of heavy duty tape.

Modules shall be filled with sand in accordance with the manufacturer's directions, and to the sand capacity in pounds for each module as shown on the plans. Sand for filling the modules shall be clean washed concrete sand of commercial quality. At the time of placing in the modules, the sand shall contain not more than 7 percent water, as determined by California Test 226.

Modules damaged due to the Contractor's operations shall be repaired immediately by the Contractor at his expense. Modules damaged beyond repair, as determined by the Engineer, due to the Contractor's operations shall be removed and replaced by the Contractor at his expense.

INSTALLATION.--Temporary crash cushion modules shall be placed on movable pallets or frames conforming to the dimensions shown on the plans. The pallets or frames shall provide a full bearing base beneath the modules. The modules and supporting pallets or frames shall not be moved by sliding or skidding along the pavement or bridge deck.

A Type R or P marker panel shall be attached to the front of the crash cushion as shown on the plans, when the closest point of crash cushion array is within 12 feet of the traveled way. The marker panel, when required, shall be firmly fastened to the crash cushion with commercial quality hardware or by other methods approved by the Engineer.

At the completion of the project, temporary crash cushion modules, sand filling, pallets or frames, and marker panels shall become the property of the Contractor and shall be removed from the site of the work. Temporary crash cushion modules shall not be installed in permanent work.

MEASUREMENT AND PAYMENT.--Temporary crash cushion modules placed in accordance with the provisions in "Public Safety" elsewhere in these special provisions will not be measured nor paid for.

5-1.07 SURFACE MINING AND RECLAMATION ACT.--Attention is directed to the Surface Mining and Reclamation Act of 1975, commencing in Public Resources Code, Mining and Geology, Section 2710, which establishes regulations pertinent to surface mining operations.

Material from mining operations furnished for this project shall only come from permitted sites in compliance with the Surface Mining and Reclamation Act of 1975.

The requirements of this section shall apply to all materials furnished for the project, except for acquisition of materials in conformance with Section 4-1.05, "Use of Materials Found on the Work," of the Standard Specifications.

5-1.08 REMOVAL OF ASBESTOS AND HAZARDOUS SUBSTANCES.--When the presence of asbestos or hazardous substances are not shown on the plans or indicated in the specifications and the Contractor encounters materials which the Contractor reasonably believes to be asbestos or a hazardous substance as defined in Section 25914.1 of the Health and Safety

Code, and the asbestos or hazardous substance has not been rendered harmless, the Contractor may continue work in unaffected areas reasonably believed to be safe, and shall immediately cease work in the affected area and report the condition to the Engineer in writing.

In accordance with Section 25914.1 of the Health and Safety Code, all such removal of asbestos or hazardous substances including any exploratory work to identify and determine the extent of such asbestos or hazardous substance will be performed by separate contract.

If delay of work in the area delays the current controlling operation, the delay will be considered a right of way delay and the Contractor will be compensated for such delay as provided in Section 8-1.09, "Right of Way Delays," of the Standard Specifications.

5-1.09 RELIEF FROM MAINTENANCE AND RESPONSIBILITY.--The following paragraph shall be added to Section 7-1.15, "Relief From Maintenance And Responsibility," of the Standard Specifications:

The Engineer will only consider "Relief from Maintenance" requests on Minor Contracts when the Engineer has suspended the work pursuant to Section 8-1.05, "Temporary Suspension of Work," of the Standard Specifications.

5-1.095 MBE, WBE AND DVBE RECORDS.--The Contractor shall maintain records of all subcontracts entered into with certified MBE, WBE or DVBE subcontractors and records of materials purchased from certified MBE, WBE or DVBE suppliers. Such records shall show the name and business address of each MBE, WBE or DVBE subcontractor or vendor and the total dollar amount actually paid each MBE, WBE or DVBE subcontractor or vendor. Upon completion of the contract, a summary of these records shall be prepared on Form CEM-2402 and certified correct by the Contractor or his authorized representative, and shall be furnished to the Engineer.

5-1.097 BLANK.

5-1.10 SUBCONTRACTING PROVISIONS.--Attention is directed to Sections 2-1.054. "Required Listing of Proposed Subcontractors" and 8-1.01, "Subcontracting," of the Standard Specifications and these special provisions.

The second paragraph of Section 2-1.054, "Required Listing of Proposed Subcontractors," is amended to read:

A sheet for listing subcontractors, as required by the Subletting and Subcontracting Fair Practices Act, is attached to the Notice to Contractors and Special Provisions.

Paragraph 3 of Section 8-1.01, "Subcontracting," of the Standard Specifications shall not apply to this contract.

5-1.11 TERMINATION OF CONTROL.--Section 8-1.08, "Termination of Control," of the Standard Specifications is amended to read :

If the Engineer deems that the Contractor has failed to supply an adequate working force, or material of proper quality, or has failed in any other respect to prosecute the work with the diligence and force specified by the contract, the Engineer may:

(a) After written notice of at least five (5) days to the Contractor, specifying the defaults to be remedied, provide any such labor or materials and deduct the cost from any money due or to become due to the Contractor under the contract, or

(b) If he considers that the failure is sufficient ground for such action give writte notice of at least five (5) days to the Contractor and the Contractor's sureties, that if th defaults are not remedied the Contractor's control over the work will be terminated.

If the defaults are not remedied within the time specified in the notice, the Contractor' control shall terminate as of the expiration of that time.

Upon such termination, the Engineer may take possession of and use all or any part of th Contractor's materials, tools, equipment, and appliances upon the premises to complete th contract. Thereupon, he may permit the surety to complete or cause the contract work to b completed, or he may direct that all or any part of the work be completed by day's labor or b employment of other contractors.

Contracts will be awarded to such other contractors only after a proposal form has beer prepared, a copy is served upon the contractor whose control has been terminated, and upor his surety, and 3 days allowed thereafter so that he may cause others to bid.

If the control of the Contractor is terminated or he abandons the work, and the work i performed by day's labor or by another contract as provided above, he is not entitled to receive any portion of the amount to be paid under the contract until it is fully completed. After completion, if the unpaid balance exceeds the sum of the amount expended by the State in finishing the work, plus all damages sustained or to be sustained by the State, the excess no otherwise required by law to be retained shall be paid to the Contractor, but if such sum exceeds the unpaid balance, the Contractor and his surety are liable to the State for the excess. If the surety completes the contract work, as provided above, such surety shall be subrogated to money due under the contract, and to money which shall become due in the course of completion by the surety, to the extent provided by law.

On the completion of the contract, the original Contractor is entitled to the return of all his unused materials, and his equipment, tools and appliances, except that he shall have no claim on account of usual and ordinary depreciation, loss, and wear and tear.

5-1.12 PARTIAL PAYMENT.--Section 9-1.06 "Partial Payments" of the Standard Specifications is amended to read:

If the number of working days for this contract is more than 20, partial payment may be made to the Contractor from time to time during the progress of the work on the basis of the Engineer's written estimate.

The estimate will include the total amount of the work done to the time of such estimate and the value thereof. The value of work done will not include the value of materials furnished but not incorporated in the work. The Department will retain 10 percent of such estimated value of the work done as part security for the fulfillment of the contract by the Contractor.

The Department will pay monthly to the Contractor, while carrying on the work, the balance not retained, as aforesaid, after deducting therefrom all previous payments and all sums to be kept or retained under the provisions of the contract. No such estimate or payment will be required to be made when, in the judgment of the Engineer, the work is not proceeding in accordance with the provisions of the contract, or when the total value of the work done since the last estimate amounts to less than five thousand dollars ($5,000).

No such estimate or payment shall be construed to be an acceptance of any defective work or improper materials.

Attention is directed to the prohibitions and penalties pertaining to unlicensed contractors as provided in Business and Professions Code Sections 7028.15(a) and 7031.

5-1.13 BLANK.

5-1.14 FINAL PAYMENT AND CLAIMS.--Section 9-1.07B, "Final Payment and Claims," of the Standard Specifications is amended to read:

9-1.07B Final Payment and Claims.--After acceptance by the Director, the Engineer will make a proposed final estimate in writing of the total amount payable to the Contractor, including therein an itemization of said amount, segregated as to contract item quantities, extra work and any other basis for payment, and shall also show therein all deductions made or to be made for prior payments and amounts to be kept or retained under the provisions of the contract. All prior estimates and payments shall be subject to correction in the proposed final estimate. The Contractor shall submit written approval of the proposed final estimate or a written statement of all claims arising under or by virtue of the contract so that the Engineer receives such written approval or statement of claims no later than close of business of the thirtieth day after receiving the proposed final estimate. If the thirtieth day falls on a Saturday, Sunday or legal holiday, then receipt of such written approval or statement of claims by the Engineer shall not be later than close of business of the next business day. No claim will be considered that was not included in the written statement of claims, nor will any claim be allowed as to which a notice or protest is required under the provisions in Sections 4-1.03, "Changes," 8-1.06, "Time of Completion," 8-1.07, "Liquidated Damages," 5-1.116, "Differing Site Conditions," 8-1.10, "Utility and Non-Highway Facilities," and 9-1.04, "Notice of Potential Claim," unless the Contractor has complied with the notice or protest requirements in said sections.

On the Contractor's approval, or if he files no claim within said period of 30 days, the Engineer will issue a final estimate in writing in accordance with the proposed final estimate submitted to the Contractor and within 30 days thereafter the State will pay the entire sum so found to be due. Such final estimate and payment thereon shall be conclusive and binding against both parties to the contract on all questions relating to the amount of work done and the compensation payable therefor, except as otherwise provided in Sections 9-1.03C, "Records," and 9-1.09, "Clerical Errors."

If the Contractor within said period of 30 days files claims, the Engineer will issue a semifinal estimate in accordance with the proposed final estimate submitted to the Contractor and within 30 days thereafter the State will pay the sum so found to be due. Such semifinal estimate and payment thereon shall be conclusive and binding against both parties to the contract on all questions relating to the amount of work done and the compensation payable therefor, except insofar as affected by the claims filed within the time and in the manner required hereunder and except as otherwise provided in Sections 9-1.03C, "Records," and 9-1.09, "Clerical Errors."

Claims filed by the Contractor shall be in sufficient detail to enable the Engineer to ascertain the basis and amount of said claims. If additional information or details are required by the Engineer to determine the basis and amount of said claims, the Contractor shall furnish such further information or details so that the information or details are received by the Engineer no later than the fifteenth day after receipt of the written request from the Engineer. If the fifteenth day falls on a Saturday, Sunday or legal holiday, then receipt of such information or details by the Engineer shall not be later than close of business of the next business day. Failure to submit such information and details to the Engineer within the time specified will be sufficient cause for denying the claim.

The Contractor shall keep full and complete records of the costs and additional time incurred for any work for which a claim for additional compensation is made. The Engineer or any designated claim investigator or auditor shall have access to those records and any other records as may be required by the Engineer to determine the facts or contentions involved in the claims. Failure to permit access to such records shall be sufficient cause for denying the claims.

Claims submitted by the Contractor shall be accompanied by a notarized certificate containing the following language:

Under the penalty of law for perjury or falsification and with specific reference to the California False Claims Act, Government Code Section 12650 et. seq., the undersigned,

_____,
(name)
_____ of
(title)
_____,
(company)

hereby certifies that the claim for the additional compensation and time, if any, made herein for the work on this contract is a true statement of the actual costs incurred and time sought, and is fully documented and supported under the contract between parties.

Dated _____

/s/ _____

Subscribed and sworn before me this _____ day
of _____.

_____
Notary Public
My Commission Expires _____

Failure to submit the notarized certificate will be sufficient cause for denying the claim.

Any claim for overhead type expenses or costs, in addition to being certified as stated above, shall be supported by an audit report of an independent Certified Public Accountant. Any such overhead claim shall also be subject to audit by the State at its discretion.

Any costs or expenses incurred by the State in reviewing or auditing any claims that are not supported by the Contractor's cost accounting or other records shall be deemed to be damages incurred by the State within the meaning of the California False Claims Act.

The District Director of the District which administers the contract will make the final determination of any claims which remain in dispute after completion of claim review by the Engineer. A board or person designated by said District Director will review such claims and make a written recommendation thereon to the District Director. The Contractor may meet with the review board or person to make a presentation in support of such claims.

Upon final determination of the claims, the Engineer will then make and issue his final estimate in writing and within 30 days thereafter the State will pay the entire sum, if any, found due thereon. Such final estimate shall be conclusive and binding against both parties to the contract on all questions relating to the amount of work done and the compensation payable therefor, except as otherwise provided in Sections 9-1.03C, "Records," and 9-1.09, "Clerical Errors."

SECTION 6. (BLANK)

SECTION 7. (BLANK)

SECTION 8. MATERIALS

SECTION 8-1. MISCELLANEOUS

8-1.01 PREQUALIFIED AND TESTED SIGNING AND DELINEATION MATERIALS.--The Department maintains a trade name list of approved prequalified and tested signing and delineation materials and products. Approval of prequalified and tested products and materials shall not preclude the Engineer from sampling and testing any of the signing and delineation materials or products at any time.

Said listing of approved prequalified and tested signing and delineation materials and products cover the following:

MATERIALS and PRODUCTS

Temporary pavement markers
Striping and pavement marking tape
Pavement markers, reflective and non-reflective
Flexible Class 1 delineators and channelizers
Railing and barrier delineators
Sign sheeting and base materials
Reflective sheeting for barricades
Reflective sheeting for channelizers
Reflective sheeting for markers and delineators
Reflective sheeting for traffic cone sleeves
Reflective sheeting for barrels and drums

None of the above listed signing and delineation materials and products shall be used in the work unless such material or product is listed on the Department's List of Approved Traffic Products. A Certificate of Compliance shall be furnished as specified in Section 6-1.07, "Certificates of Compliance," of the Standard Specifications for signing and delineation materials and products. Said certificate shall also certify that the signing and delineation material or product conforms to the prequalified testing and approval of the Department of Transportation, Division of Traffic Operations and was manufactured in accordance with the approved quality control program.

Materials and products will be considered for addition to said approved prequalified and tested list if the manufacturer of the material or product submits to the Division of Traffic Operations a sample of the material or product. The sample shall be sufficient to permit performance of all required tests. Approval of such materials or products will be dependent upon a determination as to compliance with the specifications and any test the Department may elect to perform.

The following is a listing of approved prequalified and tested signing and delineation materials and products:

PAVEMENT MARKERS, PERMANENT TYPE

Reflective pavement markers

Adelite (4x4)
Apex (4x4)
Pavement Markers, Inc., "Hye-Lite" (4x4)
Ray-O-Lite, Models SS, RS, and AA (4x4)
Ray-O-Lite, Models 2001 (2.3x4.6) and 2002 (2.4x4.7)
Stimsonite, Model 88 (4x4)

Reflective pavement markers with abrasion resistant surface

Stimsonite, Model 911 (4x4)
Stimsonite, Model 944 SB (2x4)
Stimsonite, Model 948 (2.3x4.7)
Ray-O-Lite "AA" ARS (4x4)
Ray-O-Lite Model 2002 ARS (2.2x4.7)

Non-reflective pavement markers for use with epoxy or bituminous adhesive

Apex Universal (Ceramic)
Highway Ceramics, Inc. (Ceramic)
Engineered Plastics, Inc., "Safety Dot" SD-4 (Polyester)
Zumar, TM40W/Y (Polyester)

Non-reflective pavement markers for use with only bituminous adhesive

Edco, (Marker Supply) - Models A1107 and AY1108 (ABS)
Hi-Way Safety Inc. Models P20-2000W and 2001Y (ABS)
Interstate Sales, "Diamond Back" (ABS)

PAVEMENT MARKERS, TEMPORARY TYPE

Temporary pavement markers for long term day/night use (6 months or less)

Apex Universal, Model 924 (4x4)
Davidson Plastics Co., "RPM" (4x4)
Elgin "Empco-Lite" Model 901 (4" round)

Temporary pavement markers for short term day/night use (14 days or less)

Davidson Plastics, Models TOM (Standard) with Reflexite PC-1000, or (WZ) with Reflexite AC-1000 Sheeting
Stimsonite, Model 300 "Temporary Overlay Marker"
Hi-way Safety, Inc., Model 1280/1281 with Reflexite PC-1000.
3M, Scotch-Lane A200 Pavement Marking System (4x12)

Temporary pavement markers for short term day/night use (14 days and less) at seal coat locations

Davidson Plastics, TRPM (Standard) with Reflexite PC-1000, or (WZ) with Reflexite AC-1000 Sheeting
Davidson Plastics, "HH" (High Heat) TRPM (Standard) with Reflexite PC-1000, or (WZ) AC-1000 Sheeting
Stimsonite, Model 301 Chip Seal Marker with 0.5"x4" Stimsonite Type IIIC Sheeting
Hi-way Safety, Inc., Model 1280/1281 with Reflexite PC-1000

STRIPING AND PAVEMENT MARKING MATERIAL

Permanent traffic striping and pavement marking tape

For use on high and low volume roadways

Advanced Traffic Marking, Series 300 and 400
Brite-Line, Series 1000
Swarco Industries, "Director"
3M, "Stamark" Series 380, A420, A440 and 5730

For use on low volume roadways only

3M, "Stamark" Series A320 Bisymmetric

Preformed Thermoplastic

Flint Trading, "Premark"
Pavemark, "Hotape"

Temporary removable striping and pavement marking tape

Advanced Traffic Marking, ATM Series 200
Brite-Line, Series 100
3M "Stamark" Brand, Detour Grade, Series 5710
Swarco Industries, "Director-2"

Removable Traffic Paint

Belpro, Series 250/253 and No. 93 Remover

CLASS 1 DELINEATORS

One-piece driveable flexible type (48")

All West Plastics, "Flexi-Guide 400"
Carsonite, Curve-Flex CFRM-400
Carsonite, Roadmarker CRM-375
GreenLine Model HWD1-66
GreenLine Model CGD1-66

Special use flexible type (48")

Carsonite, "Impactor" with 18" soil anchor
Carsonite, "Survivor" with 18" U-Channel anchor
FlexStake, H-D
GreenLine HWD w/18" soil anchor
GreenLine CGD w/18" soil anchor
Polyform, Inc., "Vista-Flex"
Safe-Hit, with 8" pavement anchor (SH248-GPR and SHAI-08-PI)
Safe-Hit, with 15" soil anchor (SHA5-15C-GL)
Safe-Hit, with 18" soil anchor (SH248-GPR and SHA No.-18C-PL)

Surface mount flexible type (48")

Carsonite, "Super Duck II"
FlexStake, Surface Mount H-D

CHANNELIZERS

Surface mount type (36")

Carsonite, "Super Duck" (Flat SDF-436, Round SDR-336)
Carsonite, Super Duck II "The Channelizer"
FlexStake, Surface Mount H-D
GreenLine SMD-36
Repo, Models 300 and 400
Safe-Hit, Guide Post, Model with glue down base (SH236SMA)
The Line Connection, "Dura-Post" Model DP36-3C

TYPE "K" OBJECT MARKERS (18")

Carsonite, Models SMD-615 and SMD 615-A
Repo, Models 300 and 400
Safe-Hit, Model SH718SMA
The Line Connection, Model "DP21-4K" (Vertical configuration only)

TYPE "K-4" OBJECT MARKERS (24")(Traffic Manual Type "Q")

Carsonite, Super Duck II
Repo, Models 300 and 400
Safe-Hit, Models SH824SMA--WA and SH824GP3--WA
The Line Connection, Model "DP21-4Q"

CONCRETE BARRIER MARKERS (For use to the left of traffic.)

Impactable type

All West Plastics, "Flexi-Guide 235"
Duraflex Corp., "Flex 2020"
Davidson Plastics, PCBM-12

Non-impactable type

Astro-Optics, JD Series
Stimsonite, Model 967 (with 3 1/4" Acrylic cube corner reflector)
Stimsonite, Model 967LS (with Stimsonite Type IIIC Sheeting)

THRIE BEAM BARRIER MARKERS (For use to the left of traffic.)

Duraflex Corp., "Railrider"
Davidson Plastics, "Mini" (3"x10")

CONCRETE BARRIER DELINEATORS (16") (For use to the right of traffic. Places reflective element at 48".)

All West Plastics "Flexi-Guide FG-122"
Davidson Plastics , Model PCBM-16
Safe-Hit, Model SH216RBM

GUARD RAILING DELINEATORS, (27" Wood Post Type) (For use to the right or left of traffic. Places reflective element at 48".)

All West Plastics, "Flexi-Guide 327"
Carsonite, Model 427
Safe-Hit, Model SH227GRD

GUARD RAILING DELINEATORS, (27" ~~Steel~~ Post Type) (For use to the right or left of traffic. Places reflective element at 48".)

Carsonite, Model CFGR-327 with CFGRBK300 Mounting Bracket

REFLECTIVE SHEETING FOR CHANNELIZERS AND DELINEATORS

3M, High Intensity (Long Term)
Reflexite, PC-1000, Metalized Polycarbonate (Long Term)
Reflexite, AC-1000, Acrylic (Long Term)
Reflexite, AP-1000, Metalized Polyester (Short Term)
Stimsonite, Series 4500 (For Carsonite CurveFlex and Roadmarker

REFLECTIVE SHEETING FOR BARRICADES

Type II Reflective Sign Sheeting (Engineer Grade)

American Decal, Adcolite
Avery Dennison, 1500/1600
Nikkalite (Formerly Seibulite), 8100 Series
3M, Scotchlite

REFLECTIVE SHEETING FOR TRAFFIC CONE SLEEVES

Reflexite, "SB" Vinyl, (Metalized)
Reflexite, "TR" Semi-transparent

REFLECTIVE SHEETING FOR BARRELS AND DRUMS

Reflexite, "Super High Intensity"

REFLECTIVE SHEETING FOR SIGNS

TYPE IIA (Super Engineer Grade)

Avery Dennison, "Fasign" 2500 Series
Nikkalite "Super Engineer Grade," 1800 Series

TYPE IIIA (High Performance)

3M, High Intensity

TYPE IIIC (High Performance)

Stimsonite, Series 4200 (Orange Only)
For contractor furnished signs only

Type IV

Reflexite, Vinyl (Roll-Up Signs)

SIGN SUBSTRATE FOR CONSTRUCTION AREA SIGNS

Aluminum
Fiberglass Reinforced Plastic (FRP)
Sequentia, "Polyplate"
Fiber-Brite

8-1.02 STATE-FURNISHED MATERIALS.--Attention is directed to Section 6-1.02, "State-Furnished Materials," of the Standard Specifications and these special provisions.

The following materials will be furnished to the Contractor:

Incandescent lamps for flashing beacons and sign lighting fixtures.

Traffic signal controller assembly (including wired cabinet, truck controller unit and loop detector sensor units).

Asphaltic concrete sealant for inductive detector loop installations.

Axle sensors (including epoxy).

Cellular phone system (including modem).

Completely wired controller cabinet (with auxiliary equipment) will be furnished to the Contractor at the Stockton Maintenance Station, 1604 South B Street, Stockton, CA 95206.

SECTION 9. (BLANK)

SECTION 10. CONSTRUCTION DETAILS

SECTION 10-1. GENERAL

10-1.01 MAINTAINING TRAFFIC.--Attention is directed to Sections 7-1.08, "Public Convenience," 7-1.09, "Public Safety," and 12, "Construction Area Traffic Control Devices," of the Standard Specifications and to the Section entitled "Public Safety" elsewhere in these special provisions, and these special provisions. Nothing in these special provisions shall be construed as relieving the Contractor from the responsibilities specified in Section 7-1.09.

The minimum size specified for Type II flashing arrow signs in the table following the second paragraph of Section 12-3.03, "Flashing Arrow Signs," of the Standard Specifications is amended to read "36 inches by 72 inches".

In the Standard Plans, Note 10 on Standard Plan T10, Note 9 on Standard Plan T10A, Note 5 on Standard Plan T11, Note 6 on Standard Plan T12, Note 5 on Standard Plan T13, and Note 4 on Standard Plan T14 are revised to read:

All traffic cones used for night lane closures shall have reflective cone sleeves as specified in the specifications.

The second and third paragraphs of Section 12-3.10, "Traffic Cones," of the Standard Specifications are amended to read:

During the hours of darkness traffic cones shall be affixed with reflective cone sleeves. The reflective sheeting of sleeves on the traffic cones shall be visible at 1,000 feet at night under illumination of legal high beam headlights, by persons with vision of or corrected to 20/20.

Reflective cone sleeves shall conform to the following:

1. Removable flexible reflective cone sleeves shall be fabricated from the reflective sheeting specified in the special provisions, have a minimum height of 13 inches and shall be placed a maximum of 3 inches from the top of the cone. The sleeves shall not be in place during daylight hours.
2. Permanently affixed semitransparent reflective cone sleeves shall be fabricated from the semitransparent reflective sheeting specified in the special provisions, have a

minimum height of 13 inches, and shall be placed a maximum of 3 inches from the top of the cone. Traffic cones with semitransparent reflective cone sleeves may be used during daylight hours.

3. Permanently affixed double band reflective cone sleeves shall have 2 white reflective bands. The top band shall be 6 inches in height, placed a maximum of 4 inches from the top of the cone. The lower band shall be 4 inches in height, placed 2 inches below the bottom of the top band. Traffic cones with double band reflective cone sleeves may be used during daylight hours.

The type of reflective cone sleeve used shall be at the option of the Contractor. Only one type of reflective cone sleeve shall be used on the project.

The C16 and C17 designations of the signs shown on the detail "Entrance Ramp Without Turning Pockets" of Standard Plan T14 are amended to designate the signs as R16 and R17, respectively.

Lane closures shall conform to the provisions in the section of these special provisions entitled "Traffic Control System for Lane Closure."

Personal vehicles of the Contractor's employees shall not be parked on the traveled way or shoulders, including any section closed to public traffic.

Whenever vehicles or equipment are parked on the shoulder within 6 feet of a traffic lane, the shoulder area shall be closed as shown on the plans.

Lanes shall be closed only during the hours shown on the charts included in this section "Maintaining Traffic." Except work required under said Sections 7-1.08 and 7-1.09, work that interferes with public traffic shall be performed only during the hours shown for lane closures.

Designated legal holidays are defined in "Time Restrictions" elsewhere in these special provisions.

Minor deviations from the requirements of this section concerning hours of work which do not significantly change the cost of the work may be permitted upon the written request of the Contractor if in the opinion of the Engineer public traffic will be better served and the work expedited. Such deviations shall not be adopted until the Engineer has indicated his written approval. All other modifications will be made by contract change order.

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SJ 5 R14.4/R14.7
Co. Route P.M.

LANE CLOSURE CHART No. 1

LOCATION: EASTBOUND SJ-5 PM R14.4 to PM R14.7

Lane Requirements and Hours of Work

	Midnight	1:00 AM	2:00 AM	3:00 AM	4:00 AM	5:00 AM	6:00 AM	7:00 AM	8:00 AM	9:00 AM	10:00 AM	11:00 AM	Noon	1:00 PM	2:00 PM	3:00 PM	4:00 PM	5:00 PM	6:00 PM	7:00 PM	8:00 PM	9:00 PM	10:00 PM	11:00 PM	Midnight
Mondays through Thursdays	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨					▨	▨	▨	▨	▨
Fridays	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨							▨	▨	▨	▨	▨
Saturdays	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨							▨	▨	▨	▨	▨	▨	▨	▨	▨
Sundays	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨
Day before Designated Legal Holidays	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨							▨	▨	▨	▨	▨
Designated Legal Holidays	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨							▨	▨	▨	▨	▨	▨	▨	▨	▨

Legend:

▨ One traffic lane may be closed.

☐ No lane closure allowed.

REMARKS:

Only the outside paved traffic lane and shoulder on the eastbound San Joaquin River Bridge may be closed.

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LANE CLOSURE CHART No. 2

LOCATION: Southbound Route 5 connector ramp to eastbound Route 120

Lane Requirements and Hours of Work

	Midnight	1:00 AM	2:00 AM	3:00 AM	4:00 AM	5:00 AM	6:00 AM	7:00 AM	8:00 AM	9:00 AM	10:00 AM	11:00 AM	Noon	1:00 PM	2:00 PM	3:00 PM	4:00 PM	5:00 PM	6:00 PM	7:00 PM	8:00 PM	9:00 PM	10:00 PM	11:00 PM	Midnight
Mondays through Thursdays	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒
Fridays	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒
Saturdays	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒
Sundays	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒
Day before Designated Legal Holidays	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒
Designated Legal Holidays	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒

Legend:

▒ Ramp may be closed.

REMARKS:

E.A. 10-489401

10-1.02 TRAFFIC CONTROL SYSTEM FOR LANE CLOSURE.--A traffic control system shall consist of closing traffic lanes and ramps in accordance with the details shown on the plans, the provisions of Section 12, "Construction Area Traffic Control Devices," of the Standard Specifications, the provisions under "Maintaining Traffic" and "Construction Area Signs" elsewhere in these special provisions and these special provisions.

The provisions in this section will not relieve the Contractor from the responsibility to provide such additional devices or take such measures as may be necessary to comply with the provisions in Section 7-1.09, "Public Safety," of the Standard Specifications.

Each vehicle used to place, maintain and remove components of a traffic control system on multilane highways shall be equipped with a Type II flashing arrow sign which shall be in operation when the vehicle is being used for placing, maintaining, or removing the components. Vehicles equipped with Type II flashing arrow sign not involved in placing, maintaining, or removing the components when operated within a stationary type lane closure shall only display the caution display mode. The sign shall be controllable by the operator of the vehicle while the vehicle is in motion. The flashing arrow sign shown on the plans shall not be used on the vehicles which are doing the placing, maintaining, and removing, of components of a traffic control system, and shall be in place before a lane closure requiring its use is completed.

If any component in the traffic control system is displaced, or ceases to operate or function as specified, from any cause, during the progress of the work, the Contractor shall immediately repair the component to its original condition or replace the component and shall restore the component to its original location.

When lane and ramp closures are made for work periods only, at the end of each work period, all components of the traffic control system, except portable delineators placed along open trenches or excavation adjacent to the traveled way, shall be removed from the traveled way and shoulder. If the Contractor so elects, the components may be stored at selected central locations, approved by the Engineer, within the limits of the highway right of way.

The contract lump sum price paid for traffic control system shall include full compensation for furnishing all labor, materials (including signs), tools, equipment and incidentals, and for doing all the work involved in placing, removing, storing, maintaining, moving to new locations, replacing and disposing of the components of the traffic control system as shown on the plans, as specified in the Standard Specifications and these special provisions, and as directed by the Engineer.

The adjustment provisions in Section 4-1.03, "Changes," of the Standard Specifications, shall not apply to the item of traffic control system. Adjustments in compensation for traffic control system will be made only for increased or decreased traffic control system required by changes ordered by the Engineer and will be made on the basis of the cost of the increased or decreased traffic control necessary. Such adjustment will be made on a force account basis as provided in Section 9-1.03, "Force Account Payment," of the Standard Specifications for increased work, and estimated on the same basis in the case of decreased work.

Traffic control system required by work which is classed as extra work, as provided in Section 4-1.03D of the Standard Specifications, will be paid for as a part of the extra work.

10-1.03 PORTABLE CHANGEABLE MESSAGE SIGN.--Portable changeable message signs shall conform to the provisions of Section 12, "Construction Area Traffic Control Devices," of the Standard Specifications and these special provisions.

A portable changeable message sign shall be placed in advance of each freeway lane or ramp closure (one for each lane or ramp closure system). The exact locations of the signs will be designated by the Engineer.

The contract lump sum price paid for portable changeable message sign shall include full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in furnishing, placing, operating, maintaining, repairing, replacing, transporting from location to location, and removing the portable changeable message signs, as

specified in the Standard Specifications and these special provisions, and as directed by the Engineer.

SECTION 10-2. (BLANK)

SECTION 10-3. SIGNALS, LIGHTING AND ELECTRICAL SYSTEMS

10-3.01 DESCRIPTION.--Truck warning system shall conform to the provisions in Section 86, "Signals, Lighting and Electrical Systems," of the Standard Specifications and these special provisions.

10-3.02 CONDUIT.--Conduit to be installed underground shall be the rigid steel or rigid non-metallic type unless otherwise specified. Detector termination conduits may be the rigid non-metallic type.

When a standard coupling cannot be used for coupling metal type conduit, a UL listed threaded union coupling, as specified in the third paragraph in Section 86-2.05C, "Installation," of the Standard Specifications, or a concrete-tight split coupling or concrete-tight set screw coupling shall be used.

When rigid non-metallic conduit is placed in a trench (not in pavement or under portland cement concrete sidewalk), after the bedding material is placed and conduit installed, the trench shall be backfilled with commercial quality concrete, containing not less than 376 pounds of cement per cubic yard, to not less than 4 inches above the conduit before additional backfill material is placed.

After conductors have been installed, the ends of conduits terminating in pull boxes, and in service and controller cabinets shall be sealed with an approved type of sealing compound.

At locations where conduit is required to be installed under pavement and if delay to any vehicle will not exceed 5 minutes, conduit may be installed by the "Trenching in Pavement Method."

10-3.03 PULL BOXES.--Grout shall be placed in bottom of pull boxes.

10-3.04 CONDUCTORS AND WIRING.--Splices shall be insulated by "Method B" or, at the Contractors option, splices of conductors shall be insulated with heat-shrink tubing of the appropriate size after thoroughly painting the spliced conductors with electrical insulating coating.

The Contractor shall provide the Engineer a Certificate of Compliance from the manufacturer in accordance with the provisions of Section 6-1.07, "Certificates of Compliance," of the Standard Specifications for all the conductors and cables furnished for the project.

10-3.05 SERVICE.--Continuous welding of exterior seams in service equipment enclosures is not required.

Type III service equipment enclosures shall be the aluminum type

All overlapping exterior seams and doors shall meet the requirements for Type 3R enclosures specified in the NEMA Enclosure Standards.

All multiple pole circuit breakers shall be the internal trip type.

10-3.06 STATE-FURNISHED CONTROLLER ASSEMBLIES.--The Model 334C controller assembly, including controller unit, completely wired controller cabinet and inductive loop detector sensor units, but without anchor bolts, will be State-furnished as provided under "Materials" of these special provisions.

The Contractor shall construct each controller cabinet foundation as shown on Standard Plan ES-4B for Model 332 and 334 cabinets (including furnishing and installing anchor bolts), shall

install the controller cabinet on said foundation, and shall make all field wiring connections to the terminal blocks in the controller cabinet.

A listing of field conductor terminations, in each State-furnished controller cabinet, will be furnished free of charge to the Contractor at the site of the work.

State forces will maintain all controller assemblies. The Contractor's responsibility shall be limited to that provided for in Section 6-1.02, "State-Furnished Materials," of the Standard Specifications.

10-3.07 FLASHING BEACONS.--All incandescent lamps for flashing beacon units will be State-furnished as provided under "Materials" of these special provisions.

10-3.08 DETECTORS.--Loop detector sensor units and asphaltic concrete sealant for inductive detector loop installation will be State-furnished as provided under "Materials" of these special provisions.

Loop wire shall be Type 2.

Loop detector lead-in cable shall be Type B.

The third paragraph of Section 86-5.01A(5), "Installation Details," of the Standard Specifications is amended to read:

Slots cut in the pavement shall be washed clean, blown out and thoroughly dried before installing conductors. Residue resulting from slot cutting operations shall not be permitted to flow across shoulders or lanes occupied by public traffic and shall be removed from the pavement surface before any such material flows off of the pavement surface. Residue from slot cutting operations shall be disposed of outside the highway right of way in accordance with Section 7-1.13.

Slots in asphalt concrete pavement shall be filled with asphaltic concrete sealant as follows:

After conductors are installed in the slots cut in the pavement, paint binder (tack coat) shall be applied to all vertical surfaces of slots in accordance with the provisions in Section 39-4.02, "Prime Coat and Paint Binder (Tack Coat)," of the Standard Specifications.

Temperature of sealant material during installation shall be above 70° F. Air temperature during installation shall be above 50° F. Sealant placed in the slots shall be compacted by use of an 8-inch diameter by 1/8 inch thick steel hand roller or other tool approved by the Engineer. Compacted sealant shall be flush with the pavement surface. Minimum conductor coverage shall be one inch. Excess sealant remaining after rolling shall not be reused. On completion of rolling, traffic will be permitted to travel over the sealant.

10-3.09 SIGN LIGHTING FIXTURES INCANDESCENT.--All lamps for incandescent sign lighting fixtures will be State-furnished as provided under "Materials" of these special provisions.

10-3.10 SALVAGING EXISTING WOOD POSTS.--Salvaged wood posts shall be hauled to the Stockton Maintenance Station, 1604 South B Street, Stockton, CA 95206 and stockpiled.

The Contractor shall provide equipment, as necessary, to safely unload and stockpile the material. A minimum of two working days notice shall be given prior to delivery.

10-3.11 PAYMENT.--The contract lump sum price paid for truck warning system shall include furnishing and installing wood posts for reused sign panel, modified SV-1 mounting and lag bolts and washers.

Full compensation for removing, hauling and stockpiling existing wood posts shall be considered as included in the contract lump sum price paid for truck warning system and no additional compensation will be allowed therefor.

SECTION 11. (BLANK)

SECTION 12. (BLANK)

SECTION 13. (BLANK)

SECTION 14. (BLANK)

SECTION 15. MISCELLANEOUS

DAS-OBM-1507 (8/88)

FINAL BILLING.--The State will honor cash discounts and will make payments to the Contractor in accordance with the cash discount terms specified on the invoice, provided requirements of the contract have been met. Discount must be a minimum of 1/2 of 1% of the amount due, but not less than $5.00.

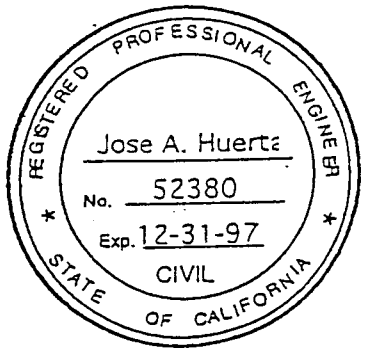
A bill in triplicate shall be submitted upon completion of the work.

THE SPECIAL PROVISIONS CONTAINED HEREIN HAVE BEEN PREPARED BY OR UNDER THE DIRECTION OF THE FOLLOWING REGISTERED PERSON.

HIGHWAY

José A. Huerta

REGISTERED CIVIL ENGINEER



Contract No. 10-489405
Contract Sheet 33 of 40
SJ 5 R14.4/R14.
Co. Route P.M.

ELECTRICAL

REGISTERED CIVIL ENGINEER

REGISTERED PROFESSIONAL ENGINEER
Hassan Marei
No. 35068
Exp. 9-30-95
CIVIL
STATE OF CALIFORNIA

Dated 5/9/95

By
District Division Chief
Division of Program and Project Management

DEPARTMENT OF TRANSPORTATION
DISTRICT 10

STATE OF CALIFORNIA

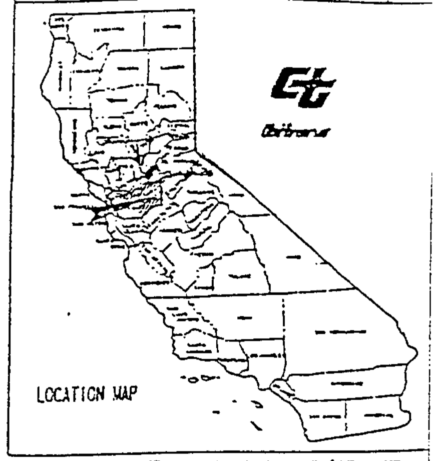
DEPARTMENT OF TRANSPORTATION

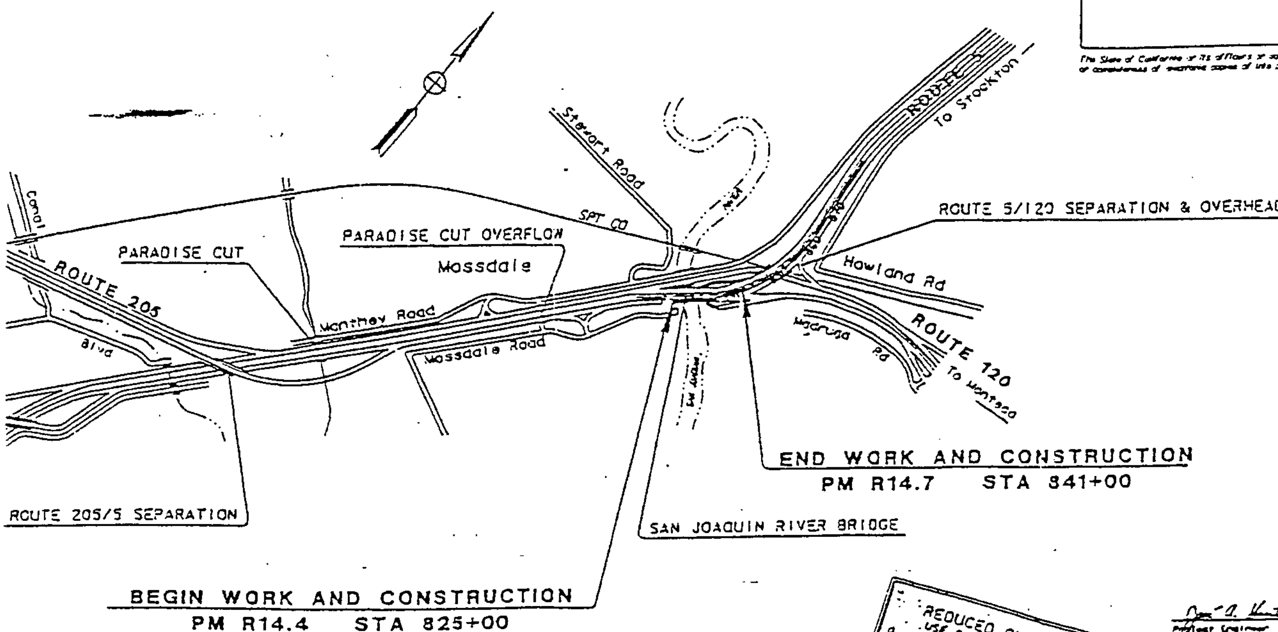
PROJECT PLANS FOR CONSTRUCTION ON

STATE HIGHWAY

IN SAN JOAQUIN COUNTY
ABOUT 9 MILES SOUTH OF STOCKTON
FROM BEGIN SAN JOAQUIN RIVER BRIDGE
TO 0.1 MILE EAST OF END SAN JOAQUIN RIVER BRIDGE

To be supplemented by Standard Plans dated July, 1992





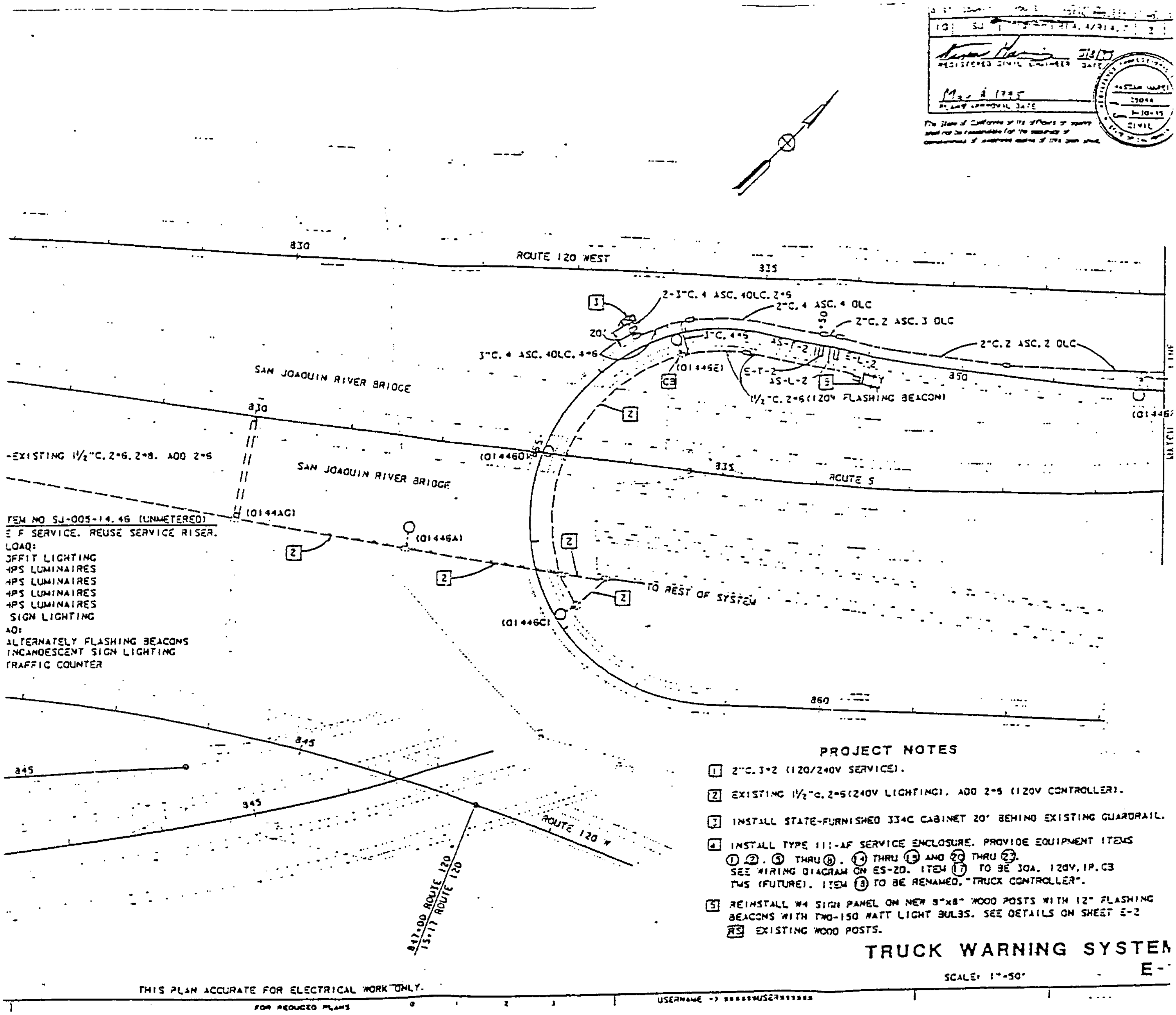
NO SCALE

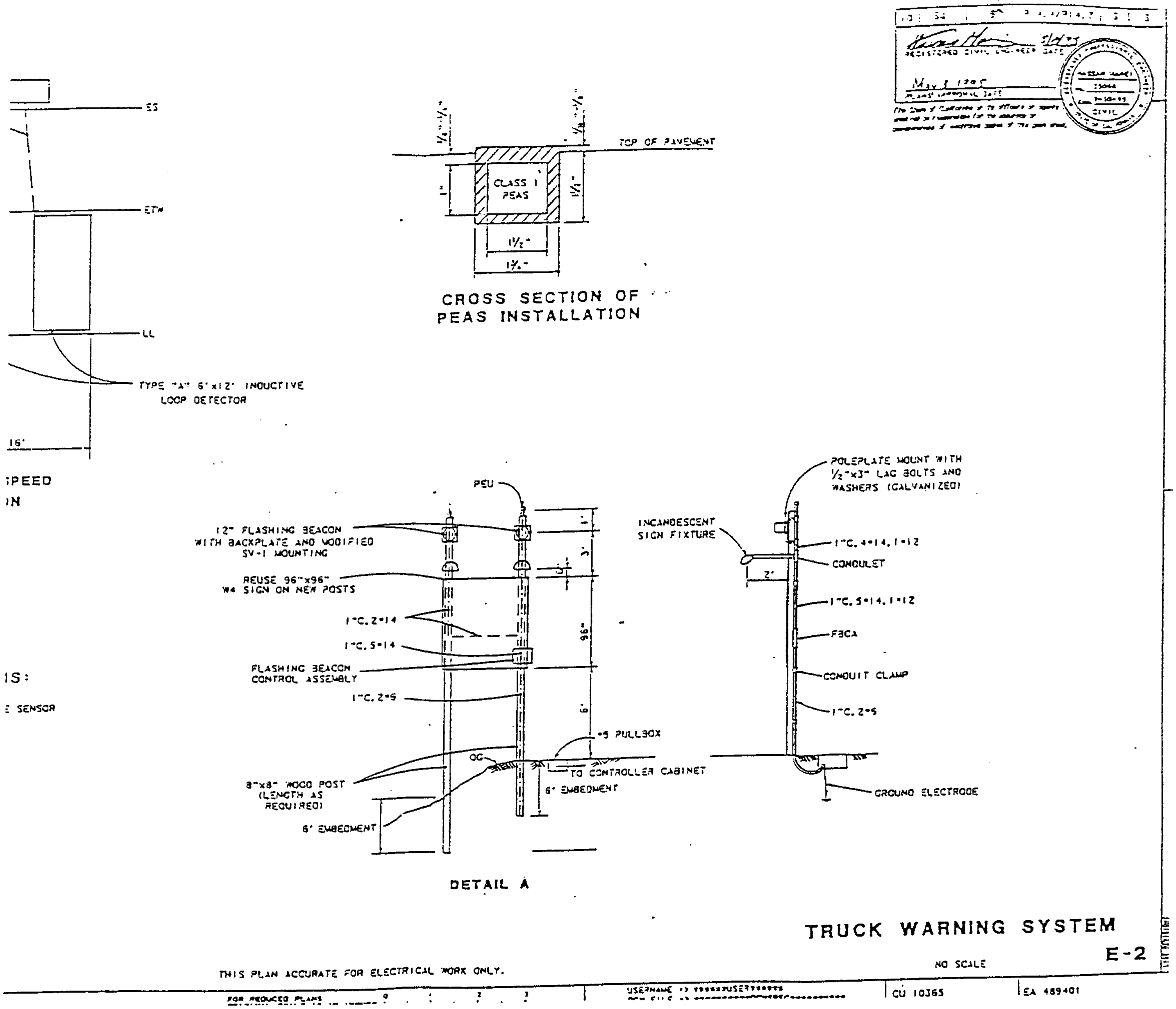
REDUCED PLAN USE SCALE BELOW

Project Engineer Date 5-5-95
Registered Civil Engineer

May 3 1995
Plans Approval Date

Contract No. 10-489405


ROUTE 120 WEST
SAN JOAQUIN RIVER BRIDGE
SAN JOAQUIN RIVER BRIDGE
ROUTE 5
TO REST OF SYSTEM
ROUTE 120 W
PROJECT NOTES
[1] 2"C. 3#2 (120/240V SERVICE).
[2] EXISTING 1½"C. 2#5(240V LIGHTING). ADD 2#5 (120V CONTROLLER).
[3] INSTALL STATE-FURNISHED 334C CABINET 20' BEHIND EXISTING GUARDRAIL.
[4] INSTALL TYPE III-AF SERVICE ENCLOSURE. PROVIDE EQUIPMENT ITEMS (1) (2), (5) THRU (8), (14) THRU (15) AND (20) THRU (23). SEE WIRING DIAGRAM ON ES-20. ITEM (17) TO BE 30A, 120V, 1P, C3 TMS (FUTURE). ITEM (3) TO BE RENAMED, "TRUCK CONTROLLER".
[5] REINSTALL W4 SIGN PANEL ON NEW 8"x8" WOOD POSTS WITH 12" FLASHING BEACONS WITH TWO-150 WATT LIGHT BULBS. SEE DETAILS ON SHEET E-2
RS EXISTING WOOD POSTS.
TRUCK WARNING SYSTEM
SCALE: 1"=50'
THIS PLAN ACCURATE FOR ELECTRICAL WORK ONLY.


TOP OF PAVEMENT
CLASS I PEAS
1½"
1¾"
CROSS SECTION OF PEAS INSTALLATION
ES
ETW
LL
TYPE "A" 6'x12' INDUCTIVE LOOP DETECTOR
16'
SPEED
IS:
SENSOR
PEU
12" FLASHING BEACON WITH BACKPLATE AND MODIFIED SV-1 MOUNTING
REUSE 96"x96" W4 SIGN ON NEW POSTS
1"C, 2#14
1"C, 5#14
FLASHING BEACON CONTROL ASSEMBLY
1"C, 2#8
8"x8" WOOD POST (LENGTH AS REQUIRED)
6' EMBEDMENT
OG
#5 PULLBOX
TO CONTROLLER CABINET
6' EMBEDMENT
96"
DETAIL A
POLEPLATE MOUNT WITH ½"x3" LAG BOLTS AND WASHERS (GALVANIZED)
INCANDESCENT SIGN FIXTURE
1"C, 4#14, 1#12
CONDULET
1"C, 5#14, 1#12
FBCA
CONDUIT CLAMP
1"C, 2#8
GROUND ELECTRODE
REGISTERED CIVIL ENGINEER DATE
PLANS APPROVAL DATE
CIVIL
TRUCK WARNING SYSTEM
E-2
NO SCALE
THIS PLAN ACCURATE FOR ELECTRICAL WORK ONLY.
FOR REDUCED PLANS
CU 10365
EA 489401

Appendix D

GUIDELINES FOR TARWS SITE REVIEW

Guidelines for TARWS Site Review

At ramps where truck rollover issues arise, District traffic personnel should answer the following questions before considering a TARWS:

1. Are Caltrans W4[3] warning signs installed in advance or on the ramp?

2. Are advanced warning flashing beacons installed on the ramp to supplement the W4 signs?

3. Is the five-year Fatal+Injury accident rate for this ramp higher than the state average for similar sites?

4. Does the truck volume (TAADT) on the ramp exceed truck volumes on other similar ramps?

5. Has their been three truck rollover and/or truck run-off road accidents in the past three years?

6. Is the advisory speed for the ramp 30 mph or less?

If you have answered YES to a significant number of these questions, a TARWS should be considered as a highway safety improvement. Refer to Section 5.3 of this report for further guidelines regarding the installation and construction of a TARWS.

[3] California Department of Transportation. Traffic Manual. Sacramento, CA. 1996: 4-17.

Appendix E

LIST OF MANUFACTURERS AND CONTACT INFORMATION

List of Manufacturers and Contact Information

Manufacturer Name	Business Address	Phone Number	Internet Address
PAT Equipment Corporation, Inc.	1665 Orchard Drive Chambersburg, PA 17201	(717) 263-7655	www.patequipment.com
International Road Dynamics, Inc.	702 43rd Street East Saskatoon, SK, Canada S7K3T9	(306) 653-6600	www.irdinc.ca