Snow & Ice Control Operations

California Department of Transportation

Maintenance Program

Mission Statement

The Maintenance Program's mission is to protect public safety and preserve California's Highway System by maintaining and repairing the system and responding to emergencies so travelers and goods reach their destination safely and efficiently.

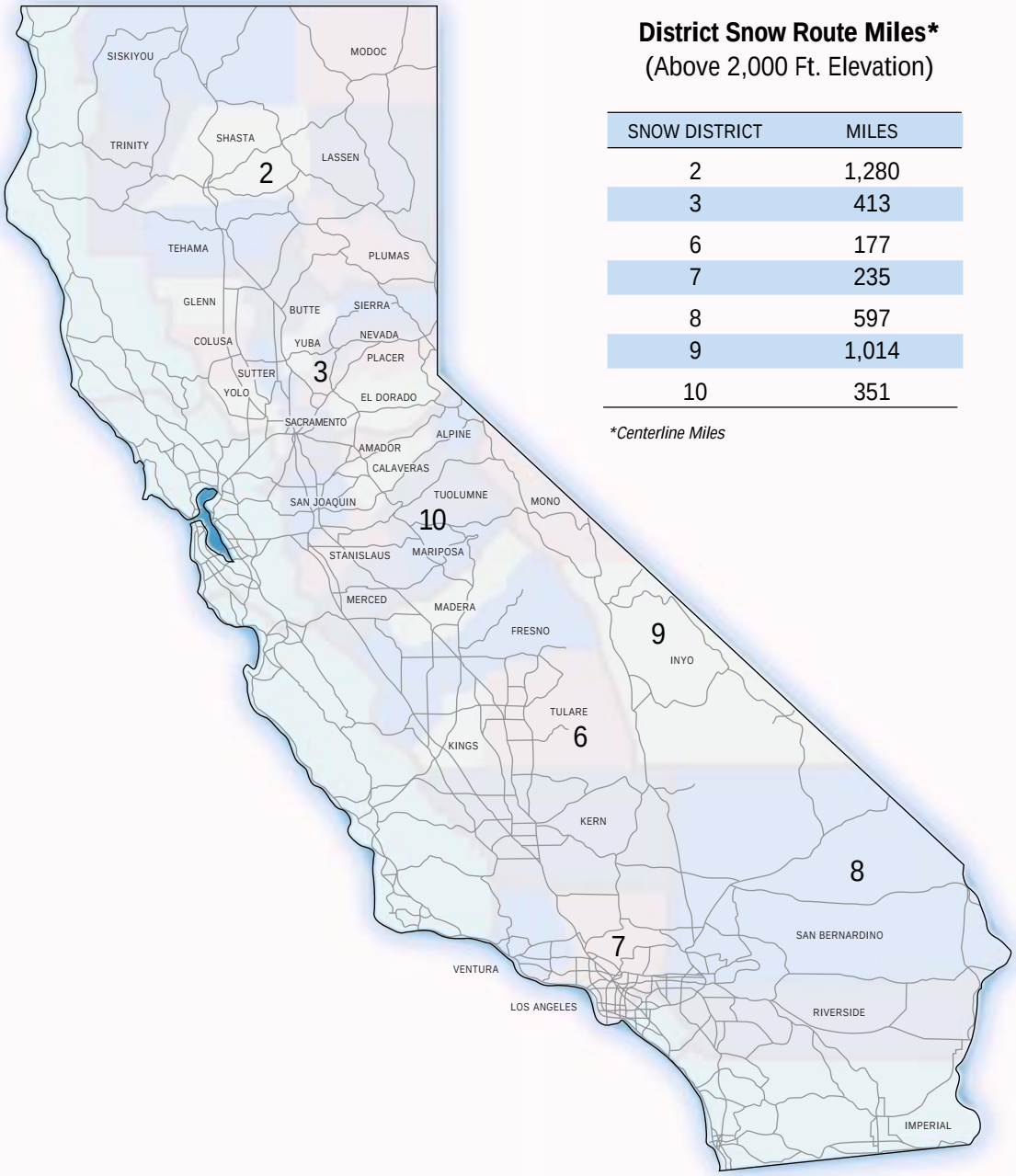
Values

- Our workforce
- Customer's time
- Teamwork
- Customer's opinions and needs
- Financial resources
- Our commitments
- Commerce and the economy
- The environment
- Continuous improvement/quality
- Innovation

CALIFORNIA DEPARTMENT OF TRANSPORTATION

Snow & Ice Control Operations

Caltrans Snow Districts



District Snow Route Miles*
(Above 2,000 Ft. Elevation)

SNOW DISTRICT	MILES
2	1,280
3	413
6	177
7	235
8	597
9	1,014
10	351

**Centerline Miles*

Introduction

The California Department of Transportation (Caltrans) has been given statutory authority for the planning, design, construction, operation, and maintenance of California's State Highway System. A key component of the maintenance of certain highways is the control of snow and ice. Caltrans maintenance forces strive to provide a safe travel way during winter conditions while keeping traffic delays to a minimum. However, Caltrans must also consider the environmental issues of snow and ice control activities. Compounding this is the traveling public's expectation that high levels of service are to be maintained, even though a route is subject to snow and ice conditions.

The large geographical area that comprises the State of California includes many different climate zones. Consequently, motorists from warmer and drier parts of the state may be unprepared for the challenges of driving in the snow during the winter.

This booklet will describe various aspects of Caltrans' methods of controlling snow and ice on mountainous highways.

Caltrans Snow and Ice Policy

The following is Caltrans' official policy on snow and ice removal from state highways:

"Snow removal and ice control shall be performed as necessary in order to facilitate the movement and safety of public traffic and shall be done in accordance with the best management practices outlined herein with particular emphasis given to environmentally sensitive areas."[1]

Rotary snow plow

[1]*Adopted July 1992. Outlined in Caltrans Report to the Legislature in response to Chapter 318, Statutes of 1991 (Hauser), "The Use of Deicing Chemicals on California State Highways" July, 1992.*

Chain Control Operations

These signs are typical, although in some areas the speed limit sign is not included.

Snow and ice control is important on every mountainous route within California; however, certain routes carry heavy seasonal recreational traffic as well as high volumes of truck traffic. These routes require extensive snow-fighting activity to keep open during heavy snow storms. This can be compounded by the fact that many motorists driving in these areas expect to be able to drive the same way they do in the summer. Also, many motorists are reluctant to pull off the traveled way and "chain-up."

Long traffic queues are not uncommon during storms on major transportation routes to and from recreational areas. In areas where traffic congestion has become a major factor in travelers' safety and snow removal efforts, provisions have been made to "meter" traffic. Traffic metering is performed at lower elevations below the snow line during chain control operations. Metering controls the volume of traffic during peak periods over snow routes, allowing smooth flow of traffic and maximum snow removal effort. The metering is conducted where food, fuel, and restrooms are available to temporarily delayed motorists.

Caltrans has defined the following chain control designations for various road conditions during snow storms:

R1a (Modified R1) Chains required for single axle drive vehicles with trailers.

R1 Chains required, except for autos or pickups with snow tires.

R2 Chains required, except for vehicles with four-wheel drive and snow tires on four wheels. (Must *carry* chains.)

R3 Chains required; no exceptions. (Note: R3 conditions are rare — the road is usually closed prior to this designation.)

The illustrations at left show the typical signs used by Caltrans for the chain requirements described above.

CHAIN CONTROL REQUIREMENTS

It is Caltrans' responsibility to determine and post chain requirements. California Vehicle Code specifies and defines "Tire Traction Devices." Traditionally, these devices have been made of steel chain.

Studded tires, while legal for use on highways during winter months, do not qualify as an approved "Tire Traction Device."

Winter traffic

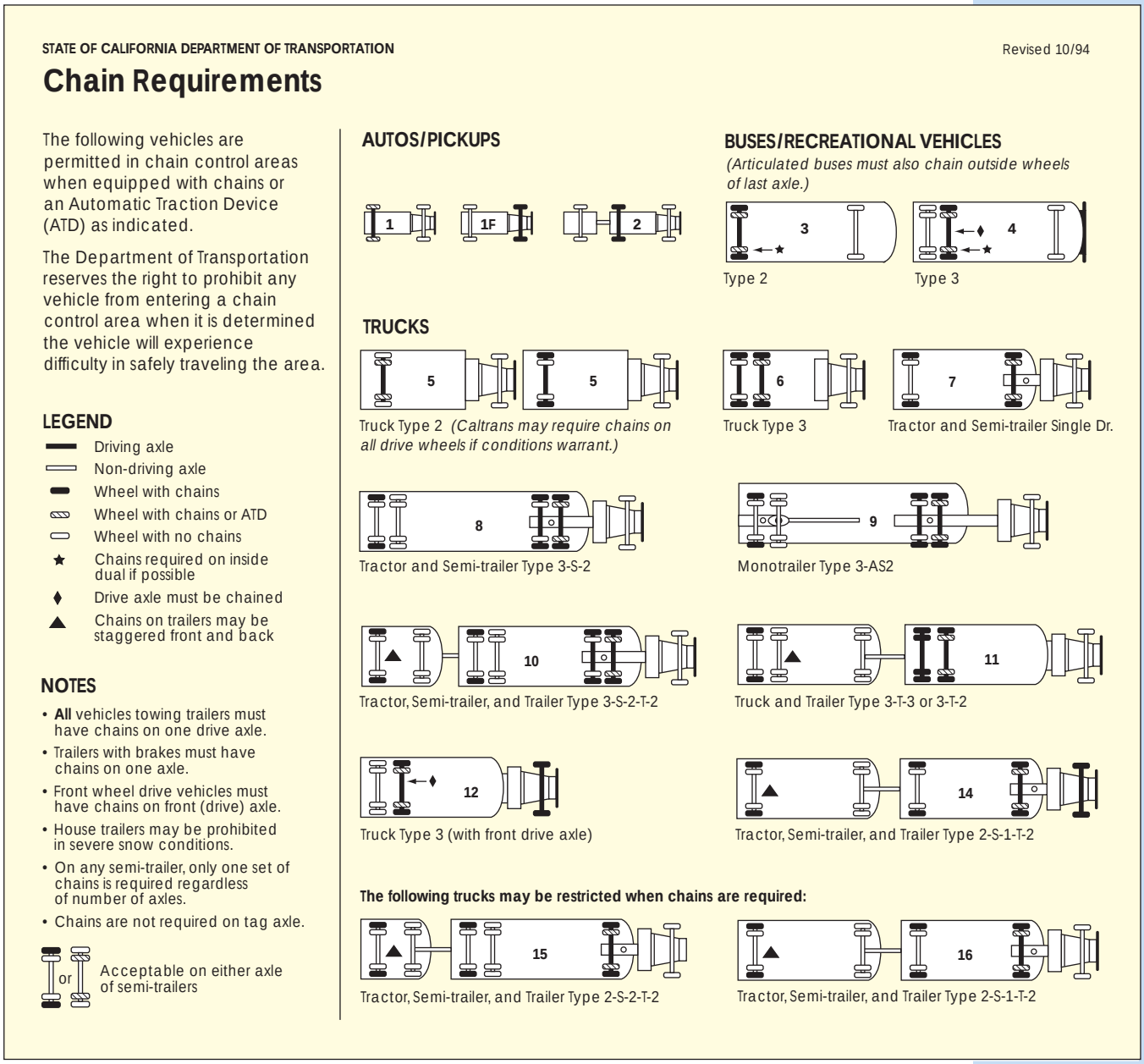
Cable type chains are approved in California when used per the proper application (see Figure 1). However, during extreme conditions, large trucks using cable chains may be held until conditions permit safe travel.

Cars and pickup trucks equipped with mud and snow tires (as alternative traction devices) are acceptable during R1 chain control conditions.

Four-wheel drive vehicles one ton and smaller with snow tires (as alternative traction devices) on all four wheels are acceptable during R2 chain control conditions.

Truckin' on the east slope of the Sierra Nevadas

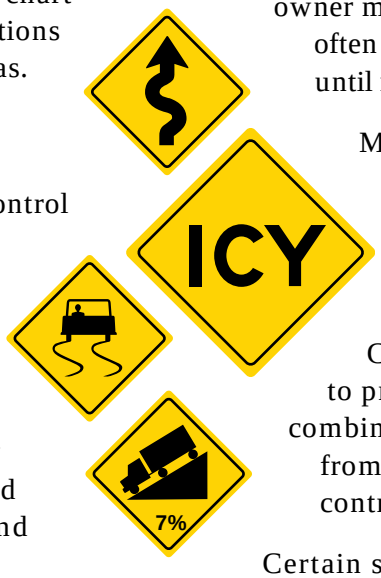
Figure 1



During R1 or R2 conditions, all vehicles including four-wheel drives that are pulling trailers must chain at least one drive axle. If the trailer is equipped with brakes, one of the trailer's braked axles must be chained also.

To aid truck drivers in the proper chaining of their vehicles, Caltrans provides the chain requirement chart to drivers at most weigh stations leading to mountainous areas.

On most major routes Caltrans provides personnel to check all vehicles at chain control points. On other routes the regulatory signs are deployed by Caltrans personnel, then left unattended.



Chain controls are generally used during snowstorms and usually end soon after the end of the storm. However, with sunshine, the snow and ice pack will begin to melt resulting in slush on the pavement that is difficult to negotiate without tire chains. Isolated shady spots can remain frozen well into the day and can be effectively treated with light applications of deicing salt or salt substitute and sand, thereby allowing chain controls to be dropped.

Due to restricted tire clearances and poor traction, certain types of vehicles present a challenge to chain control personnel at the check points. These include single drive trucks pulling double trailers, commercial auto carriers, three-axle tractors with single drive and newer front wheel drive vehicles that are restricted from chain use per their owner manuals. These vehicles are often held or may be turned back until road conditions improve.

Many motorists are unfamiliar with driving in snow and ice conditions and are likely to drive too fast for the conditions.

Caltrans reserves the right to prohibit any vehicle or combination that it deems unsafe from traveling inside a chain control area.

Certain sections of low traffic volume mountainous routes (i.e., State Routes 4, 120, 108, and others) are closed during the winter season because Caltrans has made the determination that safety concerns coupled with low traffic demands do not justify the high cost of keeping these routes open during the winter.

Carving a path through the Sierra Nevada mountains

Clearing the Roadway Surface

Caltrans utilizes snowplows and motor graders for clearing snow from the roadway surface. Deicing salt is the primary agent for ice melting and breaking the bond between the snow pack and the pavement. Abrasives, such as sand or volcanic cinders, are spread in order to provide better vehicle traction. In some areas salt is applied separately from abrasives in order to better control the location and application rate. This has proven to significantly reduce the amount of salt used.

District directors are responsible for the judicious use of salt and other chemicals for snow and ice control. Through operator training and usage logs, the Department has significantly reduced the amount of applied deicing salt. Without the use of an effective deicer such as salt, Caltrans would need to require more frequent and extended use of chains by motorists travelling mountainous routes in the winter. The use of chains, which requires lower vehicle operating speeds, combined with the operational problems presented by motorists stopping on the traveled way to install chains, significantly reduces the capacity of the highway. Another problem faced is that chain use on mountain highways contributes to pavement wear and deterioration of ride quality.

Lake Tahoe basin

The control of ice and snow on mountainous routes involves balancing the needs of the travelling public, traffic and personal safety, and the protection of the environment.

ENVIRONMENTAL CONCERNS

Although there is by no means a consensus of opinion among experts as to the magnitude of damage caused by the application of deicing salt, it is believed that deicing salt does cause some vegetation damage, as well as bridge deck and vehicle underbody corrosion.

In recognizing the potential for these kinds of harmful effects, Caltrans has implemented a reduced salt-use policy dated October 1989 and required the transportation districts to develop specific route by route plans. In the winter of 1989/90, Caltrans reduced salt usage by 62 percent statewide as compared to the previous winter. This was made possible by the combination of a mild winter and improved control of the application frequency of deicing salt.

The State of Nevada Department of Transportation, in cooperation with Caltrans, retained a private research firm to study the impacts of roadway deicing salts on vegetation within the Lake Tahoe Basin. This study, published in 1990, concluded that of 5,450 trees observed along the Lake Tahoe Basin highways within both Nevada and California, 15 percent of the trees were salt-affected. The majority of the damaged trees surveyed showed evidence of disease, bark beetle infestation and the effects of four years of drought.[2]

In addition, there is concern that deicing salt could be degrading local water supply sources in the Lake Tahoe Basin. In this regard, the Lahontan Water Quality Control Board issued board Order No. 6-89-139A directing Caltrans to perform water quality testing of certain Lake Tahoe area streams on a regular basis.[3] Caltrans annually reports back to the Lahontan Water Quality Control Board.

Another environmental concern is the usage of sand and its effects on air quality following storm conditions. Dust from airborne particulate matter is generated by vehicles driving over drying sand.

Caltrans has implemented several programs including immediate sweeping of sand deposited during a storm and the application of hydroscopic materials to the sand to attract moisture and eliminate dust from high-speed traffic. Both of these practices have proven to be effective. Caltrans is continually searching for materials, and improved operational practices to lessen the effects to the environment from our snow removal operations.

ALTERNATIVE MATERIALS

Caltrans, in response to the requirements of Assembly Concurrent Resolution 96 (Waters), evaluated several alternatives to deicing salt during the winter of 1989/90. In a report to the members of the California Legislature,[4] Caltrans reported that it had been testing two major alternative deicers, calcium magnesium acetate (CMA) and magnesium chloride. A summary of the results of the testing of these two materials follows:

Calcium Magnesium Acetate (CMA)

CMA was utilized on various routes subject to heavy snowfall in Mono County in District 9. In addition, it was tested in small amounts on test sections in Northern and Central California. During these tests, it was found that CMA was less effective than salt for deeper snow packs and does not penetrate the pack as rapidly as salt, which results in a delay in the melting of ice

[2] *"Roadside Erosion Control and Revegetation Needs Associated With the Use of Deicing Salt Within the Lake Tahoe Basin," Resource Concepts, Inc. (September 1990)*

[3] *"Report for Monitoring Program per Board Order 89-139A,Æ" Lahontan Water Quality Control Board, California Department of Transportation (February 14, 1990)*

[4] *"Evaluation of Deicing Substitutes on Certain Routes During the 1989-90 Snow Season," California Department of Transportation (July 3, 1990)*

and snow pack, particularly at temperature below 24 degrees F. CMA does, however, change the consistency of the snow pack so that it is easier to plow.

CMA can cause respiratory distress and eye irritation for personnel required to handle it, thereby necessitating the use of protective gear. CMA costs about $600 to $700 per ton as compared to salt which costs less than $50 per ton. Another problem with CMA is that it typically needs to be spread at about 1-1/2 times the rate of salt to be effective.

Magnesium Chloride

Magnesium chloride was tested on a 5-1/2 mile section of Interstate 80 near Donner Summit. At the end of storms, bare pavement was achieved more uniformly than with salt. Magnesium chloride was found to be as effective at lower temperatures as salt. Magnesium chloride, being a liquid, can be applied in a more uniform manner than granular salt, but must be kept in storage tanks. One of the drawbacks of magnesium chloride use is the fact that it should not be used on the travel way when snow pack is over 1/4 inch in depth. Applications on pack over that depth have caused the road surface to become slippery due to fast melting followed by re-freezing, necessitating additional sanding and magnesium chloride treatments to eliminate the problem.

Slip-in sanding boxes in storage

Liquid magnesium chloride appears to be a viable substitute for salt; however, it has been shown to be most effective as an anti-icer at lower elevations where frost has been a problem. Its residual effects in these areas makes it easy to apply pre-storm with re-applications not needed for several days.

Caltrans is planning to continue the use of liquid magnesium chloride, and other alternative deicers, in an effort to reduce the use of salt.

Caltrans anticipates that deicing salt will still be needed in the future, even with the use of alternative deicers, because of its cost-effectiveness and the low environmental impact in most areas of use. Caltrans districts will judiciously use salt for snow and ice control; by balancing the need to protect the environment with providing the best service to our customers.

Snow and Ice Control Equipment

Although deicing materials (salt, magnesium chloride, etc.) are useful in the control of snow and ice, snowplows and motor graders are often required to clear snow and ice from the roadway surface. Rotary snow plows are necessary to move snow off the travel way in large quantities and clear storage areas. Although equipment and methods vary according to local conditions, the following is a brief description of Caltrans equipment used to control snow and ice.

Caltrans typically uses four-, five-, and ten-cubic yard capacity trucks with push plows.

In some areas, Caltrans crews utilize trucks with wing plows that enable clearing a wide area (up to 22 feet) in a single pass. The wing plow is hydraulically extended from the side of the truck by the operator. Most trucks with plows also have the ability to spread salt or sand while plowing. Most truck-mounted plows operate at about 30-35 mph. Trucks equipped with these plows cost about $40 per hour to operate including operator.

Caltrans also uses motor graders to a large degree. Motor graders used for snow and ice removal have both front and moldboard blades which enable then to plow wide areas. Motor graders can apply considerable downward pressure (with the moldboard blade) which makes them very effective at cutting hard snow/ice pack. In areas with large snowfall amounts or that have miles of snow pack conditions, the motor grader is the operations "workhorse." They push huge quantities of snow and remove snow pack from the travel way. However, great care needs to be used by the operator, as they can cause significant damage to flexible pavements if not closely monitored. With the advances of all-wheel drive and articulated units into our service fleets, the speed and efficiency of these units have become remarkable. These advances have also increased operator comfort and control, essential for long

Rotary snow plow blowing snow

shifts and slippery roads. Due to the slower speed that they work at, they do tend to slow traffic down as it maneuvers around them. On most multi-lane highways, motor graders work in teams of two or three, staggered to allow traffic to maneuver through them, to avoid traffic back ups. Serrated blades have been used in some areas on the moldboard with success for the removal of stubborn ice and snow pack. Motor graders cost about $60 per hour to operate.

Rotary snowplows are used to blow piles and windrows of snow left by plowing out of the snow storage areas, as well as cutting through deep snow. Several of our larger rotaries have the ability to remove up to 5,000 tons of snow per hour. Rotary plows also have the ability to direct the snow blown out of the chute away from fixed objects, such as roadside signs. The rotary plows operate at a much slower speed than truck-mounted plows and motor graders (about 3-5 mph). Rotary plows cost about $120 an hour to operate.

SNOW REMOVAL PERSONNEL MANAGEMENT

Due to the seasonal nature of snow and ice control operations, Caltrans employs a large number of temporary employees. In addition to these seasonal employees, some members of other maintenance area crews are called on to assist in these operations. In rural areas, some districts use dormitories built along major routes to provide food and housing for employees that are temporarily assisting with snow removal activities. Some temporary staff members are local residents; others stay at local motels. Crews from non-snow areas of California are utilized to assist in many areas to fortify local snow crews.

Equipment Roadeo

One method of enhancing Caltrans' snow-crew training program is the Equipment Roadeo. This competitive event, which is held annually, promotes safety and professionalism in snow removal operations. Events include: tire chain installation / removal; detailed vehicle pre-trip inspection; operation of plow trucks, motor graders and front-end loaders on an event course.

Roadeo events

Caltrans districts conduct local qualifying events with finalists competing at the annual statewide Roadeo. Although contestants must use their personal time for these events, Caltrans feels that the friendly competition will improve operator performance and professionalism as well as foster "esprit de corps." Recently, Caltrans' top operators have performed well at the National Roadeo held in Colorado, including several first place finishes in 1998.

COMMUNICATIONS

In order to provide motorists with current information on highway conditions, Caltrans updates the California Highway Information Network (CHIN) phone numbers 24 hours a day.

ROAD CONDITIONS

Within California

1-800-427-7623 (ROAD)

Outside California

916-445-7623

Caltrans also provides up-to-date highway information on the Internet at the following address: http://www.dot.ca.gov/hq/roadinfo.

In order to provide motorists with current information, district maintenance personnel report current conditions to the district dispatch office, which in turn informs the Headquarters Maintenance Communications Office. In addition to CHIN and the Internet, Caltrans uses Highway Advisory Radios (HAR) along many routes to provide motorists with local road and traffic information. There are also Changeable Message Signs (CMS) permanently located along many routes to advise motorists of current conditions. Portable CMS are also used at strategic locations as needed, to advise of road and traffic conditions.

WEATHER FORECASTING

Caltrans relies on storm forecasts from the National Weather Service, various sources on the internet, and a few contracted weather forecasters. District dispatchers advise maintenance crews of impending snowstorms via telephone or radio and follow with a facsimile (FAX) of the entire forecast. Some maintenance superintendents and supervisors telephone the National Weather Service directly in order to share information concerning local conditions. Weather information via contracted satellite service is also utilized. This service provides, real-time radar, satellite, and written weather updates via satellite link. This type of service has been very reliable for reception of weather information when weather conditions have caused power and telephone outages. These types of real-time information systems have enabled snow crew supervisors to more accurately predict the timing and nature of storm cells. This enables more precise control of deicer application timing, as well as determining appropriate staffing levels, chain controls and traffic management while a storm passes through the area.

In some areas, Road Weather Information Systems (RWIS) are available to provide local pavement and atmospheric data.

Road Weather Information System

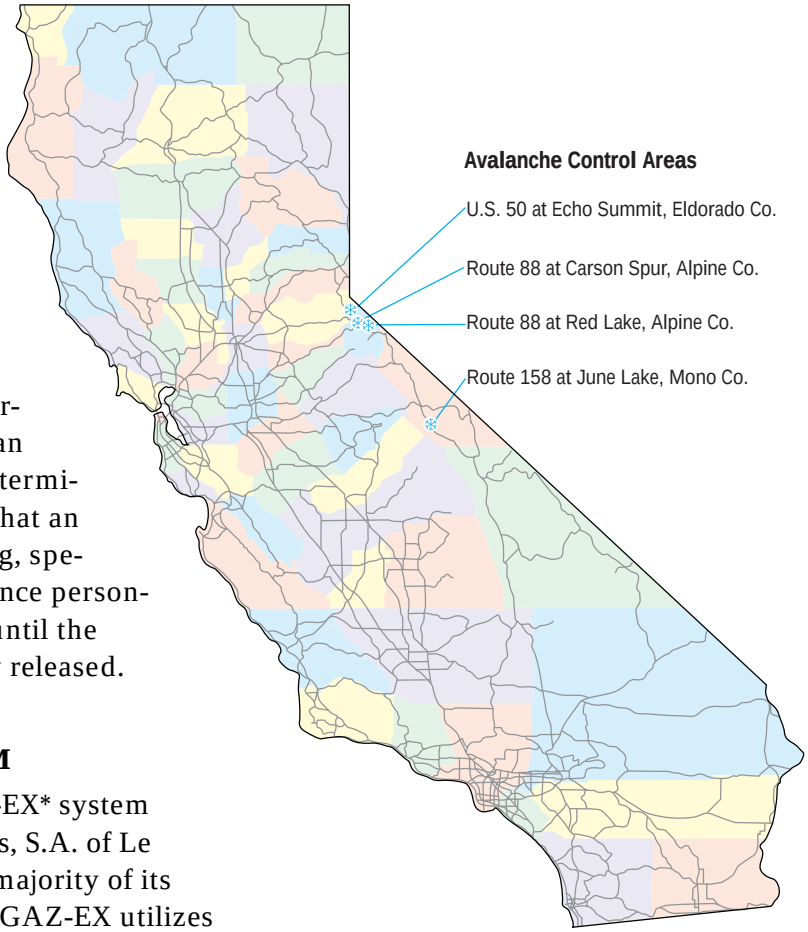
ENFORCEMENT

Caltrans has the responsibility for determining when chain controls are necessary, informing motorists of the requirements, and inspecting vehicles for conformance to the requirements. The enforcement of the chain requirements is the responsibility of the California Highway Patrol (CHP). The CHP often will station a unit (an officer and vehicle) at the chain control point. In addition, CHP units may patrol the section of the route under chain control restriction. The California Vehicle Code specifies a basic fine for violation of chain control requirements. Additionally, local jurisdictions may add additional court costs and fees.

In addition to enforcing chain requirements, the CHP also aids Caltrans in assuring the expeditious and orderly flow of traffic through the chain control area. Caltrans has the authority to set reduced speed limits of either 40, 35, 30, or 25 miles per hour, whichever is found most appropriate for the prevailing conditions.[5] The enforcement of posted speed limits within the chain control area is a CHP responsibility.

Avalanche Control Areas

Avalanches pose a substantial threat to the safety of the traveling public and Caltrans maintenance workers. To control avalanches, Caltrans or their advisors perform snow surveys in known avalanche areas to determine the likelihood of an avalanche. Once the determination has been made that an avalanche is threatening, specially trained maintenance personnel close the highway until the avalanche can be safely released.



THE GAZ-EX SYSTEM

Caltrans uses the GAZ-EX* system developed by Schippers, S.A. of Le Touvet, France for the majority of its avalanche control. The GAZ-EX utilizes

[5] *California Vehicle Code Section 22363.*

**GAZ-EX is a trademark of Schippers S.A.*

stored propane and oxygen piped into a fixed cannon located in an avalanche starting zone, directing a blast toward the ground. The system is remote controlled and is considered to be more effective and have a higher factor of safety than any other currently available system. These units have been placed throughout the state to control areas that have had historical avalanche problems.

LoCAT* commercially made artillery guns are available as a back up to the GAZ-EX system. The LoCAT units are replacements for the outdated U.S. military 75 mm recoilless rifles that were retired from active duty with Caltrans in 1997. The LoCAT system utilizes compressed air to propel a seven-pound explosive payload to the target area. We are continually looking for lower cost, more effective solutions to avalanche control to improve operational safety and productivity.

GAZ-EX avalanche control cannon

In some parts of the state, for close range avalanche control work, a low-pressure inert gas propelled projectile is fired from the Avalauncher.** This device has limited range, but is simple to operate at a relatively low cost.

The last resort in our avalanche control arsenal is the deployment of explosive hand charges. This operation is very time consuming and requires trained and certified personnel. These hand-charging operations often take place during the most extreme conditions on the snow laden cornice areas over looking the highways. Dedicated employees apply their special skills in hand throwing these charges to release avalanches in areas where other methods are not effective or available.

LoCAT avalanche control system

** LoCAT is a trademark of SSE, Inc.*

***Avalauncher is a trademark of Avalanche Control Systems.*

Improvements in Snow and Ice Control

Caltrans is always looking for new methods and equipment to improve its snow and ice control operations.

The use of traffic sensing equipment, such as pavement loops, in the travel corridors leading to the mountains could provide important traffic data to chain control points. This data could be useful to manage traffic entering a chain control area, allowing for more efficient plowing and traffic movement.

Wire-guidance systems embedded in the pavement on sections of highways that experience winter closures are being used and evaluated. These systems enable snow plow operators to safely reopen the closed road by indicating the plow truck's location on the snow-buried roadway.

A Global Positioning System (GPS) vehicle guidance system is currently being installed and tested in several places in the state. One of these systems will be evaluated on Interstate 80 over Donner Summit to see if it has value in assisting motorists and snow removal equipment while driving and working in poor visibility.

In a related application, a structure called a "jet roof" is installed on the top of a ridge near Carson Pass on Route 88. The "jet roof" alters the wind patterns that normally blow across the ridge area creating dangerous snow cornices. If not prevented, these cornices can suddenly give way in an avalanche of snow onto the highway below.

Currently under development is a system to measure snow removal level of service. Caltrans believes that by consistently measuring we can implement performance-based adjustments to personnel, equipment, and materials. Cost savings, improved service to our customers, and safer winter travel are the goals of this program.

Close-up of jet roof *(above)*; Jet roof array above Carson Pass *(below)*

Conclusion

The maintenance of California's highways is increasingly challenged in that higher public expectations and increasing traffic are complicating operations.

Motor grader at work

In order to maintain satisfactory levels of service, Caltrans must strive for maximum effectiveness from its crews, equipment and materials. The snow and ice control program is no exception.

Caltrans will strive to incorporate new products and techniques into snow and ice control. Increased training opportunities for snow and ice control personnel and improvements in traffic management and information systems will maximize the utilization of provided resources while protecting the safety of the traveling public, maintenance personnel and the environment.

References

1. *Maintenance Manual*, Volume One, California Department of Transportation (June 1998)

2. *Snow Fence Guide*, Strategic Highway Research Program (October 1991)

3. *The Use of Deicing Chemicals on California State Highways*, Caltrans Report to the Legislature in Response to Chapter 318, Statutes of 1991 (Hauser)

4. *Evaluation of Deicing Substitutes on Certain Routes During the 1989-90 Snow Season*, California Department of Transportation, Report to the Legislature as Required by Resolution Chapter 157, Statutes of 1989 (ACR 96 Waters) July 1990

5. *Roadside Erosion Control and Revegetation Needs Associated With the Use of Deicing Salt Within the Lake Tahoe Basin*, Resource Concepts, Inc. (September 14, 1990)

6. *California Vehicle Code*, California Department of Motor Vehicles

For More Information

Mr. Kris Kuhl ..... (916) 654-5789
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http://www.ca.gov.hq/roadinfo

Listen to the Signs

In all weather conditions, Caltrans highway workers need your help. Always remember:

- Slow down when passing a work area. Stay alert and leave enough time for travel. Pay attention to the signs.
- Be careful. Just like you, Caltrans workers want to return home safely tonight.
- Maintain control of your vehicle. Stay focused on the job at hand – driving safely.
- Obey all warning signs and watch for equipment. Workers may be nearby.
- NEVER drive while under the influence of drugs or alcohol.

Caltrans

Road Conditions

Within California
1-800-427-7623 (ROAD)

Outside California
916-445-7623

Callers can use a touch-tone phone for recorded messages on road conditions. After dialing, enter the route number and touch the pound sign (#).

California Relay Service
TTY 1-800-735-2929

Internet Access
http://www.dot.ca.gov

For information while in Western Nevada – from Reno, Sparks, Carson City, North and South Shore Lake Tahoe

(702) 831-6677

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