## Washington State DOT Speed Management

Interstate 90, which is the primary east-west route across Washington State, experiences rain and fog in summer months and snow and ice in the winter. This freeway crosses the Cascade Mountains through Snoqualmie Pass, which is a popular tourist destination. Roadway geometry, the volume of truck traffic (i.e., 22 percent), and recreational travelers unfamiliar with local conditions contributed to a winter crash rate that was four times the annual average. The Washington State Department of Transportation (DOT) employs a speed management technique on a 40-mile (64-kilometer) segment of the freeway to improve roadway safety in the presence of fog, snow, and ice.

*System Components*: The speed management system is comprised of six Environmental Sensor Stations (ESS), 22 radar vehicle detectors, Remote Processing Units (RPUs) housed in roadside cabinets, 13 Dynamic Message Signs (DMS), Variable Speed Limit (VSL) signs, a central control system, as well as digital radio and microwave communication systems. The ESS are installed along the interstate to detect air temperature and humidity, precipitation, wind speed, pavement temperature and condition (e.g., dry, wet, icy), and pavement chemical concentration. ESS data and vehicle speed data are collected by RPUs and transmitted to a control computer in the maintenance office located in Hyak. Advisory messages and reduced speed limits are posted on the DMS and VSL signs, as shown in the figure.


**Washington State DOT**
**Reduced Speed Limit on DMS**

*System Operations*: The central control computer provides decision support by utilizing software algorithms to process field data, calculate safe speeds, and suggest speed limit reductions during adverse conditions. If system operators agree with the recommendations DMS and VSL signs are activated to display road weather advisories, reduced speed limits, and the reasons for lower speeds. The control computer allows system operators to modify speed limits by direction and by road section. DMS may also be used to alert drivers of roadway closures necessitated by winter maintenance and avalanche control activities.

When warranted, the speed limit is reduced in 10-mph (16-kph) increments from 65 mph (104.5 kph) to 35 mph (56.3 kph) based upon prevailing road, weather, and traffic conditions. Vehicle equipment (e.g., tire chains) may be regulated to improve vehicle traction. Control strategies for various road weather conditions are shown in the following table.

**Washington State DOT Speed Management Control Strategies**

| Weather Conditions | Pavement Conditions | Control Strategies |
|---|---|---|
| • Light to moderate rain<br>• Visibility distance greater than 0.5 mi. (0.80 km) | • Dry<br>• Wet | Speed limit at 65 mph (104.5 kph) |
| | | No tire regulations |
| • Heavy rain<br>• Fog<br>• Visibility distance less than 0.2 mi. (0.32 km) | • Slushy<br>• Icy | Speed limit reduced to 55 mph (88.4 kph) |
| | | Traction tires advised |
| • Heavy rain or snow<br>• Blowing snow<br>• Visibility distance less than 0.1 mi. (0.16 km) | • Shallow standing water<br>• Compacted snow/ice<br>• Deep slush | Speed limit reduced to 45 mph (72.4 kph) |
| | | Traction tires required |
| • Freezing rain<br>• Heavy rain or snow<br>• Blowing snow<br>• Visibility distance less than 0.1 mi. (0.16 km) | • Deep standing water<br>• Deep snow/slush | Speed limit reduced to 35 mph (56.3 kph) |
| | | Tire chains required |

*Transportation Outcome*: Speed management has improved roadway safety by prompting drivers to significantly decrease speed in inclement conditions. A University of Washington study found that although speed variance increased slightly, speed management reduced average speed by up to 13 percent.

*Implementation Issues*: An examination of historical crash statistics determined that the winter crash rate was significantly higher than the annual average. Crash frequency in the presence of snow was five times the rate under clear conditions. The crash rate in January was 12 times higher that the July crash rate. High travel speeds and speed variance were found to contribute to winter crashes, which were primarily rear-end, sideswipe, and run-off-the-road type. Based upon these findings, the Washington State DOT decided to employ speed management to enhance roadway safety under low visibility or slippery pavement conditions.

The DOT hired a consultant to provide design, integration, and support services for system components. The DOT selected field equipment locations, designed sign support structures, assessed communication system options, and purchased DMS hardware. The DOT's Radio Operations department considered the licensing, installation, and maintenance issues associated with telephone, radio, microwave, and satellite communications technologies. The cost of installing 40 miles (64 kilometers) of telephone cable through the mountainous terrain of the Snoqualmie Pass was prohibitive. High costs and topography also precluded utilization of satellite communications. Thus, multiple microwave and radio communication links were designed to transmit data from the roadway to the mountaintop and from the mountaintop to the Hyak maintenance office. The DOT chose a DMS with light-emitting diode technology for high visibility in adverse weather conditions and procured the signs under a separate contract to ensure that performance criteria were met.

After system components were deployed in winter 1997, the Washington State DOT established policies and procedures to guide system operation. Traffic managers, system operators, maintenance personnel, state police, and others involved with the system were consulted during development of these policies. Policies and procedures covered staffing and training requirements, the reporting structure, message sets, and various response scenarios.

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*Reference(s)*:
- Booz-Allen & Hamilton, "Compendium of Field Operational Test Executive Summaries," http://www.itsdocs.fhwa.dot.gov/jpodocs/repts_pr/32301!.pdf.
- Jasper, K., "Cross-Cutting Study of Advanced Rural Transportation System ITS Field Operational Tests," Booz-Allen & Hamilton, presented at the 1998 Transportation Conference, http://www.ctre.iastate.edu/pubs/crossroads/245cross.pdf.
- Robinson, M., et al, "Safety Applications of ITS in Rural Areas," prepared by Science Applications International Corporation (SAIC) for FHWA, September 2002, http://www.itsdocs.fhwa.dot.gov//JPODOCS/REPTS_TE//13609.html.
- Science Applications International Corporation (SAIC), "Examples of Variable Speed Limit Applications," presented at the Transportation Research Board (TRB) Annual Meeting, January 2000, http://safety.fhwa.dot.gov/fourthlevel/ppt/vslexamples.ppt.
- Senn, L., "Variable Speed Limit And In-Vehicle Signing Operational Test," Washington State DOT, http://www.wsdot.wa.gov/eesc/atb/atb/html/TA.html.
- Senn, L. and Bjorge, E., "ITS Field Operational Test Contracting: Avoiding Surprises," Washington State DOT, http://www.wsdot.wa.gov/eesc/atb/atb/html/ITSA.html.
- Ulfarsson, G., et al, "TRAVELAID," Final Report, prepared by Washington State Transportation Center (TRAC) in cooperation with Washington State DOT, December 2001, http://www.itsdocs.fhwa.dot.gov//jpodocs/repts_te//13610.html.
- Ulfarsson, G., et al, "Summary: TRAVELAID," Summary Report, prepared by Washington State TRAC in cooperation with Washington State DOT, February 2002, www.wsdot.wa.gov/ppsc/research/CompleteReports/WARD511_2TravelAidSummary.pdf.
- Ulfarsson, G., et al, "The Effect of Variable Message Signs on the Relationship between Mean Speeds and Speed Deviations," prepared by Washington State TRAC in cooperation with Washington State DOT, presented at the Transportation Research Board (TRB) Annual Meeting, July 2001.

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