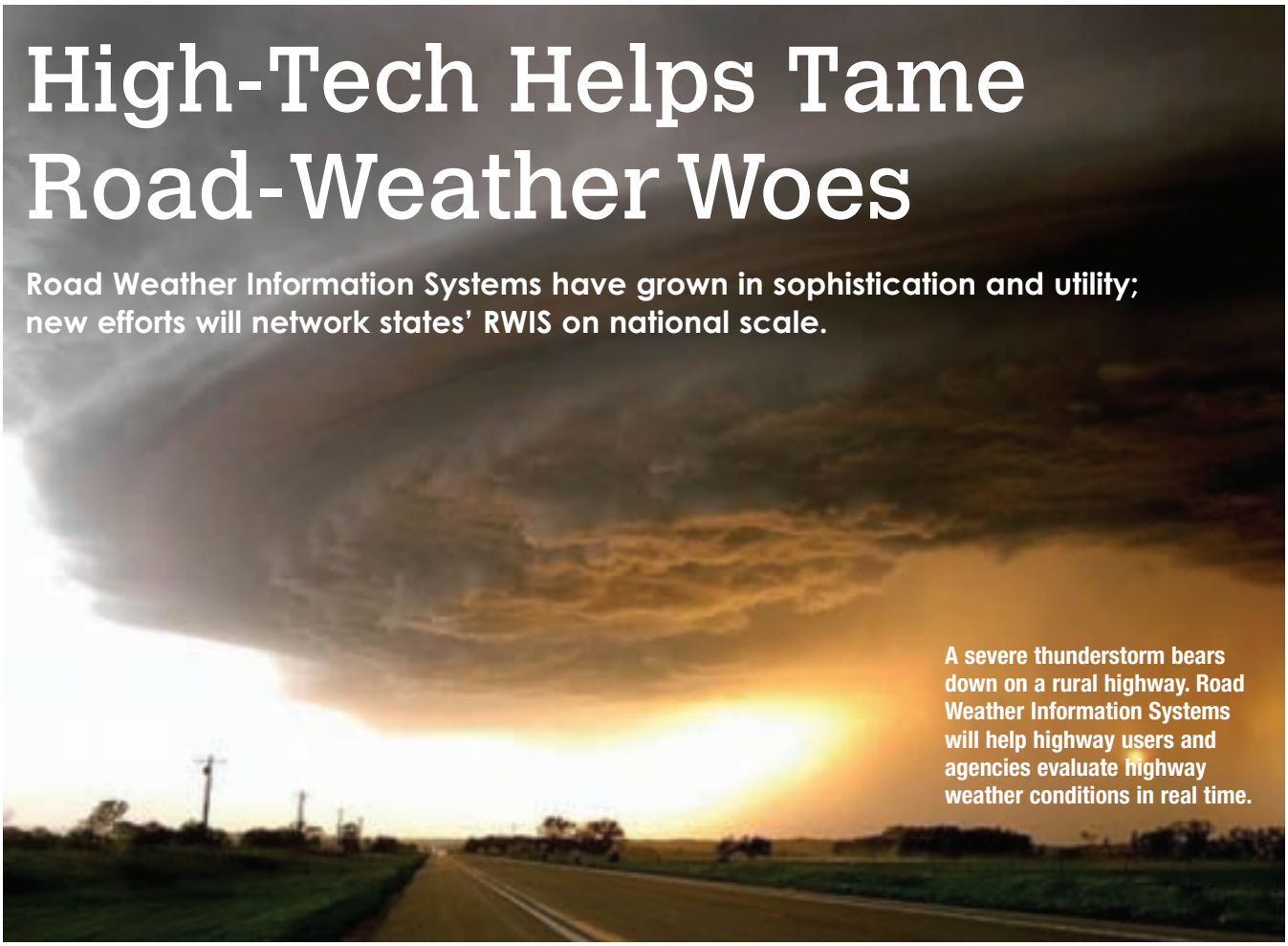
ROAD SCIENCE

by Tom Kuennen, Contributing Editor

High-Tech Helps Tame Road-Weather Woes

Road Weather Information Systems have grown in sophistication and utility; new efforts will network states' RWIS on national scale.



A severe thunderstorm bears down on a rural highway. Road Weather Information Systems will help highway users and agencies evaluate highway weather conditions in real time.

Photo courtesy of the FHWA.

Weather can be an obstacle and a danger for America's motorists.

Rain and drizzle slow traffic, fog causes killer pile-up accidents, and snow and ice on pavements cost a not-so-small fortune to control.

And while there still is nothing anyone can do to alter or control the weather, new technologies are being developed and applied today that help road managers and users determine what road conditions are across the state — or the nation — in real time; track winter, severe storms, and dust storms as they make their way through a jurisdiction; and, using real-time surface and subsurface information, fine-tune a response to predicted road conditions to the point that the response can be proactive, rather than reactive, with substantial cost savings for taxpayers.

These state and local Road Weather Information Systems (RWIS, pronounced "are-wiss") can be accessed on the Internet on a state-by-state basis, among those states which maintain them. Through the *Aurora* pooled fund program, states are cooperating in research on RWIS that already is bearing fruit. Another pooled fund program, *Clear Roads,* studies research in equipment.

But work also continues at the federal level in networking these systems, where the *Clarus* initiative will make state RWIS data available at a single-point source, and its *MDSS* (Maintenance Decision Support System) program will provide road agencies at every level of government with new tools to optimize anti-icing and snow and ice control expenditures via enhanced decision making. And all this is taking place as the private sector and academia develop new products and applications.

Ultimately, the new Intelligent Transportation System technologies will integrate RWIS data collection as well, turning each vehicle into a weather condition collector on a microclimate basis.

The current surface transportation funding bill (SAFETEA-LU, 2005) provides $5 million per year from 2006 to 2009 to establish a road weather management research and development program to begin developing solutions that will lead to new technologies aimed at improving the utilization of advanced weather information by transportation stakeholders. It's just part of the ongoing development of RWIS early in the 21st century.

Weather a source of congestion

Why all the fuss? Today's weather information technologies promise great improvements in traffic congestion, safety, and mobility, given weather's impact on surface transportation. That's because adverse weather is the second largest cause of non-recurrent congestion, says the Federal Highway Administration.

"Snow, ice, and fog alone cause 15% of non-recurring delay," the FHWA said. "Likewise, a light rain can increase travel time delay by 12 to 20%. This translates into financial impacts. In metropolitan areas, truckers lose about $3.4 billion (about 32 million hours) stuck in weather-related traffic delays in the nation's metro areas. A one-day highway shutdown can cost a metropolitan area up to $76 million in lost time, wages, and productivity."

Road Weather Information systems help transportation system operators warn highway users of changing weather and manage the infrastructure. The RWIS data also helps road managers respond to future conditions in real time, effecting significant savings in material, labor costs, and congestion.

Predominant among these benefits is the ability to pre-treat pavements with anti-icing materials before a winter storm strikes. Just because radar indicates icy precipitation is coming doesn't mean a road will ice up. Whether ice forms (or snow sticks) on a road depends not only on its surface temperature, but the relative humidity at the location, and the residual temperature in the pavement subbase. An RWIS with below-pavement sensors will tell a road agency what kind of icing, if any, to expect, even if the temperatures above ground are below freezing. And if frozen precipitation is expected to stick, an RWIS will help an agency make proactive snow and ice control decisions, thus avoiding unnecessary overtime.

Environmental Sensor Systems with road sensors are the basis of a Road Weather Information System, shown here in Utah (above) and Iowa (below).

Photos courtesy of the Center for Transportation Research and Education, Iowa State University.

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RWIS can help fine-tune a response to predicted road conditions, for a proactive, rather than reactive, response with substantial cost savings for taxpayers.

Going below pavement

"RWIS goes further than just an above-ground weather station getting all the atmospherics," said Lee Smithson, P.E., American Association of State Highway & Transportation Officials. "There will be a temperature probe buried in the pavement subgrade, which will indicate what kind of heat- or cold-sink the road base may be providing. In the fall, the air temperature may be below freezing, but the heat sink below will be warming the pavement. If you can skip an application of chemistry because you know the pavement won't freeze, you can accrue tremendous savings in labor and material, especially if the work is done on overtime."

Photo courtesy of the FHWA.

Snow and ice control decisions have grave consequences in urban areas.

On the other hand, a mild spring night with high humidity can lead to frost or black ice on pavements if the subgrade is frozen. "RWIS helps guide the decision-making process as to what kind of chemistry a road agency will use," Smithson said.

These systems are already making a difference. For example, maintenance managers in Idaho reduced crashes by 83%, labor hours by 62%, and material costs by 83% using road weather sensors to manage the application of anti-icing treatments.

Combined with changeable message signage, Road Weather Information Systems can enhance freeway management, including variable speed limits, depending on real-time surface conditions and traffic signal optimization through adaptive control, Federal Highways says. Other benefits can include accelerated incident response, and above all, real-time weather conditions information made available to highway users and managers using varied media, including the Internet.

And RWIS is not limited to snow and ice control. In Tennessee, a fog detection and warning system on I-75 resulted in a decline in fog-related crashes from more than 200 between 1973 and 1993, to just one between 1994 and 2002, the FHWA reports.

What is an RWIS?

According to Aurora, the pooled-fund program which unites state transportation departments with an interest in RWIS for common research goals, a Road Weather Information System can be defined as a combination of technologies that uses historic and current climatological data to develop road and weather information (for example, nowcasts and forecasts) to aid in roadway-related decision making.

Aurora says the three main elements of RWIS are:

- Environmental sensor system technology to collect data.
- Models and other advanced processing systems to develop forecasts and tailor the information into an easily understood format.
- Dissemination platforms on which to display the tailored information.

Environmental Sensing Stations (weather stations) are components of RWIS that provide the real-time environmental data that the system needs. There are over 2,400 of these stations in 49 states and the District of Columbia. Both atmospheric (weather) and surface data must be collected. Weather data include air temperature, amount and type of precipitation, visibility, dew point, relative humidity, and wind speed and direction. Surface data include pavement temperature, subsurface temperature, surface condition (dry, wet, frozen), amount of deicing chemical on the roadway, and freezing point of the road surface. These data are collected by sensors placed at the roadside or in the roadway itself.

There are over 2,400 environmental sensing stations in 49 states and the District of Columbia.

Aurora maintains that data must be processed as well as collected. That's why remote processing units are placed along the roadways, which contain some or all of the road and weather sensors.

In some cases, the pavement sensors are located apart from the remote processing unit, with several pavement sensors capable of being linked to one unit. However, these remote units have limited local

Photos courtesy of the FHWA.

Barrier-mounted fog warning lights (above) are useful in guiding traffic through fog-shrouded highways (inset).

intelligence for processing, so data are transmitted to a central server, which could be generically termed a central processing unit. This central server is typically located in a highway maintenance facility and provides communication, collection, archiving, and distribution of the data.

The raw data are used directly or in coordination with a service provider to prepare *nowcasts* or forecasts, Aurora says. Forecasts can be used to predict site-specific weather and pavement conditions. Real-time weather information is important, although, the greatest benefits are accrued through the use of tailored forecasts such as those aimed specifically at supporting maintenance operations.

Informed maintenance decisions

Nevada's Road Weather Information System consists of meteorological stations along highways that allow the transportation department to make more informed management decisions during winter storms. Specialized equipment and computer programs monitor air and pavement temperature to make forecasts regarding how the winter storms impact the highways, helping road managers decide when to apply alternate deicing chemicals, make optimal use of materials and staff, and practice anti-icing techniques developed through years of research.

Likewise, California's RWIS uses meteorological stations along pavements to collect local pavement and atmospheric data. Each environmental sensing station in the system utilizes sensing devices, which are placed below the highway surface and on towers well above the roadway, some as tall as 33-feet high. At the tower's height, weather data such as air temperature, rainfall, and wind speed are measured and collected, while road sensors determine if the roadway surface is wet, dry, frosted, snow covered, or iced. Some of the stations utilize video cameras to relay visual information about weather and road conditions such as fog, rain, and snow.

"Information gathered from the RWIS equipment allows the Traffic Operations and Maintenance staff to make informed decisions during winter storms," Caltrans says. "These weather stations monitor air and pavement temperature to make forecasts regarding how the winter storms may impact the highways. The road sensors inform maintenance personnel of road conditions and existing concentrations of deicing chemicals, such as salt, to help them determine when the road surface will freeze. This gives Caltrans Maintenance crews the information they need to make optimal use of materials and staff."

By reporting on a relatively small area, the system can give drivers detailed information about conditions in their immediate vicinity. The system also provides statewide data and can, for example, track a storm to help predict when it will hit a specified area.

"Because RWIS will indicate when conditions will be right tonight for frost or black ice formation, it will indicate to a supervisor what might be done this afternoon to be proactive, such as spray for anti-icing," Iowa's Smithson told *Better Roads*. "The water in the chemistry will dry, leaving a concentration of chemicals on the pavement. If only crystals were placed, the traffic would soon blow them off. Only a liquid will stick to the pavement for effective, proac-

Today's RWIS environment can be directly traced to the Strategic Highway Research Program (1988-1993).

tive anti-icing, and that will prevent having to call someone out at 2 a.m. and pay overtime to get ahead of the frost."

"The benefits will be improved operations and safety for the traveling public, and improved operations for the public agency," said Paul Pisano, Team Leader, Road Weather Management Program, FHWA Office of Operations. "It's not just a snow-belt thing, because rain, flooding, wind, dust, and fog also impact travel, particularly in the South and East. The investments to-date in RWIS have provided benefits, but we see an opportunity to take it further, and maximize the value of these public investments."

Photo courtesy of Surface Systems Inc.

Use of anti-icing techniques, compared to deicing, can save time and money if the weather conditions and pavement/subgrade temperatures are right.

There is more to Road Weather Information Systems than proactive response to potential icing situations. "The system started as a winter maintenance tool, and the ability to be proactive with snow and ice is the biggest benefit to-date," Pisano told *Better Roads*. "But the states found that when they put these systems in, that RWIS are not just a winter maintenance tool; this is something that traffic managers, incident management teams, and emergency response personnel can use. It also is of value for roadside vegetation spraying and traffic lane stripe spraying operations. There is so much more that RWIS can do other than winter maintenance."

For example, if an incident response team knows that a local rain shower is in a particular location, it can concentrate its resources there rather than be spread out.

SHRP launched today's RWIS

Today's RWIS environment can be directly traced to the Strategic Highway Research Program (1988-1993), which found a more efficient way to clear snow and ice is to treat the pavement *before* conditions make it ripe for snow to stick.

This strategy, known as *anti-icing*, relies on information supplied by RWIS. Two SHRP projects were developed. Project H-207 examined the emerging technology of RWIS, and Project H-208 considered the development of anti-icing technologies. At the conclusion of the SHRP program, the work conducted by the anti-icing project team and the participating states was expanded and continued under the FHWA Test and Evaluation Project 28 for an additional two years. The result was the *Manual of Practice for an Effective Anti-icing Program: A Guide for Highway Winter Maintenance Personnel* (to obtain as a .pdf file, see *For More Information* sidebar).

After Project 28, from 1995 to 2000, members of a Lead States Team for Anti-icing/RWIS provided states with guidance and technical assistance on the use of these techniques for snow and ice control. The Lead States Team included the New York State, Pennsylvania, Minnesota, Iowa, Colorado, Nevada, Washington State, and Missouri departments of transportation; the FHWA; private sector leaders Surface Systems, Vaisala, and Spray Center Electronics; and the University of Iowa.

In September 2000, the Lead States Team transferred its responsibilities to the Subcommittee for Maintenance of the American Association of State Highway and Transportation Officials, specifically, the subcommittee's task force for snow and ice.

Today, the AASHTO Snow and Ice Pooled Fund Cooperative Program aims to help cities and counties, as well as the states. "AASHTO provides the administrative support and the funding mechanism, and works in cooperation with the American Public Works Association, the National Association of County Engineers, and the FHWA," said Smithson, AASHTO SICOP coordinator, and a founder of Aurora.

Aurora: Dawn of new age

But the bulk of RWIS research is being conducted through the auspices of Aurora, which maintains an ambitious research program and posts dozens of research papers and presentations at its Web site, *www.aurora-program.org*.

The bulk of RWIS research is being conducted through the pooled-fund Aurora program, which maintains an ambitious research schedule.

"Aurora is helping us speed up research," Smithson said. "When Aurora was formed, all we had for research money was from the National Cooperative Highway Research Program. Being the new technology on the block, we didn't stand much of a chance against the technologies that were up and running. So several state DOTs decided to develop our own highly focused, pooled fund, and Aurora was founded in 1996."

Domestic member DOTs include Alaska, Illinois, Indiana, Iowa, Minnesota, New York State, North Dakota, Ohio, Pennsylvania, Tennessee, Utah, Virginia, and Wisconsin; international members include Quebec Ministry of Transportation, Ontario Ministry of Transportation, and Swedish Road Administration.

Photo courtesy of the FHWA.

This giant ice cutter is a unique Caltrans weapon for use in keeping mountain highways open.

"Aurora is a group of states which got together to research RWIS-related matters," said Dennis Belter, Aurora program chair, and maintenance administration manager, Indiana DOT. "It's everything RWIS. We will research everything from the accuracy of sensors, to how the RWIS ties into different systems, and much more."

Aurora shares specifications, system maintenance, and other information. "We want to continually improve the information to people who are doing snow and ice removal," Belter said. "Until RWIS got started, there really wasn't anything to tell a foreman what the pavement was doing. We're using Aurora to focus on the pavement."

Clear Roads is a state pooled-fund research program for rigorous testing of winter maintenance materials, equipment, and methods.

Among Aurora's current projects are *Benchmarking the Performance of RWIS Forecasts; Development of an RWIS Quality Assurance Monitoring System; Evaluation of Vaisala Spectro Pavement Sensor; Guidelines for Testing, Installation, Maintenance, and Calibration of Pavement Sensors; Improved Frost Forecast Model: Phase II; Intelligent Image-Based Winter Road Condition Sensor: Phase III; Low Cost Mobile RWIS;* and much more. Information on all these, plus concluded research and future research items, are available off Aurora's Web site (see sidebar).

Aurora is not standardizing RWIS reporting from coast to coast, leaving that for the FHWA's Clarus program (below). "We are fully supportive of Clarus as something that will help us in the long run," Belter told *Better Roads*. "If we can continue to get pavement information to the National Weather Service or any other provider, if they have good historical and current information, the outcome will be better forecasts for us."

"One of the big challenges is the need to get all this information together," Belter said. "Historically, each state has gone on its own and did not talk to each other. The FHWA's Clarus is working to draw the states together. Plus, we're always trying to improve accuracy. We've gotten a lot smarter about sensors and what they can provide us. Now we are researching an infrared sensor that's not intrusive on the pavement, unlike the hockey pucks that fit into the pavement, with connecting lines to the RWIS tower. The technology continues to advance."

Make way for Clear Roads

While Aurora is a state DOT pooled-fund research program for RWIS implementation, Clear Roads is a similar state pooled-fund research program for rigorous testing of winter maintenance materials, equipment, and methods for use by highway maintenance crews.

"Aurora researches and deploys RWIS technology, with a tight focus on RWIS," Smithson said. "Clear

Clear Roads participating states include Wisconsin, Iowa, Minnesota, Missouri, Indiana, Michigan, Ohio, Colorado, and Illinois.

Roads conducts rigorous, structured research on snow and ice removal equipment, materials, and methods."

Created by state winter maintenance engineers in 2004, Clear Roads responds to a need for research based on practical experience. Participating states include Wisconsin, Iowa, Minnesota, Missouri, Indiana, Michigan, Ohio, Colorado, and Illinois.

Through participating state agencies, Clear Roads conducts field testing and evaluation across a range of winter conditions and highway maintenance organizational structures. Clear Roads projects are intended to immediately share useful data and recommendations on the effectiveness, ease of use, optimum application rates, durability, and more, of many advanced winter operations technologies.

Current research includes:

■ **Calibration of Manual and Ground-Speed-Controlled Salters.** With the goal of determining the calibration accuracy of ground-speed-controlled salters, this study is documenting controller settings, actual salt usage, and prewetting rate information from trucks with various types of controller units during winter storm events. Results will include guidelines to help snowplow operators establish and maintain accurate calibration of ground speed controllers, reducing salt usage and improving efficiency.

■ **Synthesis of Best Practices for Eliminating Icing and Fogging on Winter Maintenance Vehicles.** This study is investigating best practices for eliminating fogging and icing on winter maintenance vehicles. The researcher will conduct a comprehensive survey to identify effective methods for combating or preventing moisture on windows and mirrors while maintaining the comfort and safety of the plow operator. Results will include a compilation of the most effective designs, technologies, materials, and practices for keeping snowplow glass and mirror surfaces clean of winter precipitation inside and out.

■ **Snowplow Design.** The Clear Roads Technical Advisory Committee is guiding a research project on snowplow design in coordination with a Concept Vehicle pooled fund. Researchers met this spring to brainstorm alternative plow designs that would maximize efficiency. Two prototype plows will be built in Indiana and Iowa.

Photo courtesy of the FHWA.

RWIS-aided anti-icing, under the right situations, is an opportunity to reduce conventional plowing at all hours.

The FHWA, Aurora, SICOP, and Clear Roads are planning a national snow and ice conference for 2007 that will attract winter maintenance professionals from around the country.

In collaboration with the FHWA, Aurora, and SICOP, Clear Roads is planning a national snow and ice conference for 2007 that will bring together winter maintenance professionals from around the country. The meeting will likely take place in Columbus, Ohio, around the Eastern Winter Road Maintenance Symposium and Equipment Expo.

The next meeting of the Clear Roads Technical Advisory Committee will take place in St. Louis, January 9-10, 2007. The committee will be discussing and selecting new research projects to fund in 2007.

FHWA's Clarus and MDSS

Even as Aurora combines state resources to fund research in RWIS, the Federal Highway Administration is actively working to link these systems together into an organic national whole via the Clarus project.

Clarus — Latin for clear — is developing an integrated surface transportation weather observing, forecasting, and data management system. The objective of Clarus is to provide information to all transportation managers and users nationwide that can be used to alleviate the effects of adverse weather on surface transportation.

Two components comprise Clarus: Initial development of the Clarus system, which is a network for sharing, quality checking, and exchanging surface environmental data and relevant surface transportation conditions; and development of tools (such as decision support systems) that make effective use of the Clarus system.

Clarus will provide a national clearing house of quality-controlled RWIS information for the entire country.

"There was a huge RWIS resource out there that public agencies had invested in, but wasn't being utilized to its fullest," the FHWA's Pisano told *Better Roads*. "So FHWA kicked off the Clarus initiative to design, demonstrate, and develop the capability of assimilating all of these observations into one place, running quality checking algorithms on them to make sure the data are good, reporting that information back to the DOTs, but also disseminating this information to anyone who wants or needs it, to turn it into value-added information products for weather and road conditions."

Future smart cars and roadways will be tailor-made for collection, transmission, and analysis of real-time weather information.

Clarus will provide a national clearinghouse of quality-controlled RWIS information for the entire country. "Somebody in Nebraska is going to want to know what's happening in Wyoming because that weather is coming his way," Pisano said. "But there is more to it; it comes back to services like MDSS and the state Web sites, the 511 information program. We know people want and need good road weather information; Clarus provides the opportunity to make that information better."

Contemporaneous with Clarus is the FHWA's *Maintenance Decision Support System,* which is taking the pro-activity concept a step further. "MDSS is the next generation of RWIS," FHWA's Pisano said. "Instead of just saying 'here is the weather information and pavement temperature forecast,' MDSS will take that information, apply it to a coded-up, computer-based rules of practice, which will turn that raw information into a recommended treatment. It not only will say that there is a weather problem, but add 'because of that weather problem and your rules of practice, we recommend that you apply 250 pounds of road salt per lane mile on this route at this time.'"

Right now, the FHWA and its public and private sector stakeholders have developed a federal prototype of MDSS that is a core software program in the public domain. A fourth version is available through the NCAR Web site (see sidebar for ordering information). In line with the FHWA development approach, several private sector firms now provide MDSS services to their state DOT customers based on the prototype.

Clarus will provide a North American resource that can collect, quality-check, and make available surface transportation weather and road condition observations so state DOTs and other transportation agencies can be more productive in maintaining safety and mobility, while optimizing their RWIS/ESS investments.

The Future: RWIS meets ITS, VII

In the long run, RWIS will become part of our Intelligent Transportation System architecture, woven into the forthcoming Vehicle-Infrastructure Integration (VII) initiative now in the planning stages. At great expense, VII will make roads safer by deploying advanced vehicle-vehicle and vehicle-infrastructure communications that could keep vehicles from leaving the road and enhance their safe movement through intersections.

VII envisions equipping all new cars and trucks with mobility- and safety-enhancing intelligent vehicle technologies, while at the same time outfitting roadways and intersections throughout America with intelligent technologies. Essentially, the *smart* vehicles would be linked to the *smart* highway infrastructure (as well as each other) via a nationwide, wireless communications network, with enormous potential for reducing crashes and enhancing the mobility of the roadway system.

A public-private VII Coalition has been formed and will determine if the infrastructure deployment can be synchronized with the vehicle integration. Based on their planned development and exploration, the *VII Coalition* will not render its final decision for a nationwide rollout until the 2008 timeframe.

But the future *smart* cars and roadways of VII will be tailor-made for collection, transmission, and

Photo courtesy of Surface Systems Inc.

Pavement-mounted anti-icing sprayers can be remote-operated if an RWIS indicates an icing event is imminent.

analysis of real-time weather information. Even now, most cars carry onboard thermometers, and luxury models can detect airborne precipitation, which automatically triggers windshield wiper operation. In the meantime, onboard anti-skid computers analyze tire-pavement friction and automatically initiate anti-lock braking in skid situations. Air-density sensors that could indicate relative humidity are used in conjunction with fuel injectors. All of these common environmental indicators could be put to use for real-time pavement conditions on a microscale.

"Recent advancements in weather detection and prediction, communication and networking, and ITS technologies (e.g., onboard data sampling, telematics, in-vehicle computing, and so on) facilitate the development of new surface transportation weather capabilities," said the Intelligent Transportation Society of America's Weather Information & Applications Special Interest Group, in its report, *Transportation Weather Research and Development Needs to Support ITS*. "The technical components necessary to significantly advance surface transportation weather are either in place or quickly emerging. The time is right to begin moving forward to couple advanced weather and Intelligent Transportation System technologies."

"As we develop Clarus we are recognizing the emerging opportunity to collect data from mobile platforms, that is, vehicles," FHWA's Pisano told *Better Roads*. "The VII program is exploring communications between vehicles, and between roadside devices. There is a huge amount of data that a vehicle collects today that tells us about weather conditions, or something about the environment from which we can infer a weather condition."

Ultimately, information such as *Black Ice Ahead, 100 feet* will become available on the dashboard of a vehicle, as it approaches pavement that other vehicles have sensed. Testing of such a system is forthcoming and is just a part of the growing intersection of RWIS and intelligent transportation systems. **BR**

For More Information

A blizzard of information on Road Weather Information Systems is available to road agencies and contractors. Here are places to start.

■ The *Best Practices for Road Weather Management* (May 2003) project captured a variety of road weather management strategies used by maintenance, traffic, and emergency managers to mitigate the impacts of weather. It contains case studies from every region of the country, a listing of over 200 road weather publications, an overview of environmental sensor technologies, and online resources (including 39 statewide road weather condition Web sites). Download the manual at *http://ops.fhwa.dot.gov/ Weather/best_practices/1024x768/right_main.htm.*

■ The Federal Highway Administration publication resulting from the Strategic Highway Research Program's Test and Evaluation Project 28 is the *Manual of Practice for an Effective Anti-icing Program: A Guide for Highway Winter Maintenance Personnel* (FHWA-RD-95-202, June 1996). Download the .pdf file at *http://ops.fhwa.dot.gov/Weather/about.htm.*

■ New research and documents are available at the Aurora Web site, including a final report of the *Guidelines for Testing, Installation, Maintenance, and Calibration of Pavement Sensors;* a database of RWIS specifications and users survey results; the 2005-2006 Aurora Program Work Plan; and a research report, *Transportation Weather Research and Development Needs to Support ITS*, prepared for ITS America. See all of these reports, and much more, at *www.aurora-program.org/index.cfm.*

■ The Iowa DOT maintains a Web site with real-time weather information from points and highways all across the state. The site includes both Roadway Weather Information System and Automated Weather Observing System data, both current and historical. Access it at *www.dotweatherview.com/.*

■ The Nevada DOT operates an enormous RWIS network, and data are accessed in real time at multiple points along Nevada highways. Experience this Java-enabled wonder at *www.nevadadot.com/traveler/rwis/.*

■ The Strategic Highway Research Program studied anti-icing and RWIS, and work continued via a Lead States Team. Find out more about what they did at *http://leadstates.transportation.org/rwis/*. The site also provides links to research publications such as the *Guide for Selecting Anti-Icing Chemicals*, which specifies key performance measures for anti-icing chemicals, and helps agencies weigh these measures according to their specific needs; *Best Practices of Outsourcing Winter Maintenance Services* guidelines; the Lead States Team Transition Plan; *Anti-Icing and RWIS Technology in Canada;* and an anti-icing/RWIS *1999-2000 Technology Transfer and Usage Survey Results*. See them at *http://leadstates.transportation.org/rwis/library/.*

■ A report summarizing the state-by-state activities of COMET — *Lessons Learned from Collaborative Research on Road Weather Observations and Predictions* — may be downloaded as a .pdf at the Turner-Fairbank Highway Research Center Web site at *www.tfhrc.gov/its/pubs/04101/index.htm/.*

■ The Clear Roads initiative parallels the work being done by Aurora, but focuses on equipment, deicing and chemicals application, and research. Read more about Clear Roads, and download their brochure, at *www.clearroads.org/.*

■ FHWA's Clarus Initiative is described in *Clarus Initiative: Concept of Operations and Associated Research,* by Paul A. Pisano and James S. Pol, FHWA, and Lynette C. Goodwin and Andrew D. Stern, Mitretek Systems, Inc., Falls Church, Virginia. Download it at *http://ams.confex.com/ams/Annual2006/techprogram/paper_101715.htm.*

■ The AASHTO SICOP Web site hosts a variety of research and application papers which are of interest to states, cities, and counties. Access it at *www.sicop.net/.*

■ The 2004 opus of the National Academy of Sciences, *Where the Weather Meets the Road: A Research Agenda for Improving Road Weather Services*, is available for purchase or reading for free online. Visit *www.nap.edu/catalog/10893.html.*

■ A one-day training course on the *Fundamentals of Road Weather Management* is offered through the National Highway Institute course No. 137030A. This course will introduce transportation decision makers to RWIS and how these systems can be applied to address a host of weather-related problems. Topics include a review of road weather problems, meteorology for the non-meteorologist, technology resources and implementations, and case studies. A follow-up course on RWIS Implementation is also planned. Learn more about the course from Paul Pisano at *paul.pisano@fhwa.dot.gov.*

■ The MDSS software and a variety of other technical publications on the Road Weather Maintenance Decision Support System are available off the National Center for Atmospheric Research Web site at *www.rap.ucar.edu/projects/rdwx_mdss/.*