

A POLICY FORUM: WEATHER AND HIGHWAYS

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Panel 3

**Policy Issues In Implementing Effective
Application Of Weather Services To The
Management Of The Nation's Highway System**

POSITION PAPERS

Improving the Management of the Nation's Highway System By Effective Application of Weather Services

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Background

Highway traffic fatality statistics for 2002 tell a grim story of grief, pain and economical loss. The nationwide fatality total of 42,815 is the highest level since 1990 and 604 more than were killed in 2001. Safety initiatives to reverse this trend are a major part of the AASHTO program. On June 2, 2003, AASHTO convened a State Leadership Forum of federal and state officials, law enforcement officials, motor vehicle administrators, safety and industry leaders to commit to a comprehensive effort to drive down highway fatalities. Funding is necessary to make programs happen, so AASHTO joined efforts with the American Association of Motor Vehicle Administrators, the Governors Highway Safety Association, the International Association of Chiefs of Police, and the Commercial Vehicle Safety Alliance to form the State Highway Safety Alliance. The efforts of this Alliance will focus on obtaining increased funding and effective safety measures in the six-year reauthorization of the Transportation Equity Act for the 21st Century. AASHTO is committed to advance safety on the nation's highways.

Safety advances are usually accomplished through programs and initiatives. Safety programs have typically been built around the three "E's", engineering, education, and enforcement. This forum on "Weather and Highways" introduces a fourth "E", "environment", in particular the "environment" caused by bad weather. While a few threads of weather have been woven into the fabric of "engineering" and "education", weather and applied weather research have not had the focus that this AMS Policy Forum is accomplishing. This tightly focused effort is appropriate because the driving environment is so adversely affected by bad weather. Approximately 7,000 highway deaths and 800,000 injuries each year are associated with poor weather related driving conditions.

The impact of bad weather goes beyond the societal and economic costs associated with fatalities and injuries. A significant challenge is related to how the public and the economy have become ever more reliant on the highway system. Most goods and services are dependent on "just-in-time" delivery, so disruption in mobility causes considerable negative economic impact. Adverse weather also impacts emergency management, incident management, evacuations, and traffic management. Accurate weather forecasts are essential ingredients in producing effective outcomes from the planning, emergency response and preparedness processes. Effective weather management will aid in the reduction of delay due to all incidents, which in rural areas accounts for all delay and for about half of delay in urban areas.

Weather Management Systems

The disruption of winter weather in the 34 snow-belt states of the US results in considerable loss when a blizzard brings transportation and the economy to a stand still. The Strategic Highway Research Program (SHRP) produced significant research results for improving snow and ice

control operations and reducing the impacts of major winter storms. Technology advances such as the use of Road Weather Information Systems (RWIS) and proactive snow and ice control operations such as Anti-Icing operations are being implemented in most snow belt states. New approaches to storm management such as the Maintenance Decision Support System (MDSS) produced by FHWA are being evaluated. The goal of the MDSS is to fuse data from road and weather sources and provide the snow and ice control decision-maker with an expert decision support tool that generates recommendations on road maintenance courses of action together with anticipated consequences of action or inaction. Winter field evaluations indicate that the accuracy of weather forecasts and in particular the pavement surface interface must improve before the benefits of these technologies can be optimized.

Motorist Information

The motoring public is developing an awareness of the impact of weather on the roadway system. A 2002 Gallup public opinion poll indicated that 40% of the potential users on a national “511” system identified weather as the most important information element they needed. “511” usage during the winter of 2002-2003 was impressive. Tennessee officials report that phone calls to “511” for road conditions during winter storms exceeded 60,000 calls per day. Iowa “511” recorded 100 hits per second to their web site during winter storms causing them to increase their incoming capacity. The media played an important role in informing the public about the “511” service, especially during winter storm events. Iowa expanded its system this past summer to include information about road construction and maintenance activities that may affect travel times.

Focus Questions

The foregoing discussion points out the need for improving the safety and mobility of the nation’s highway system that can be addressed through effective application of road weather services. There are both opportunities and impediments that will impact the application of this weather information.

1. What are the key institutional and financial policy issues in promoting effective application of highway weather information?

- National Weather Service does not include provision of tailored weather services to state or local governments, so private sector providers need to be included in the dialog since they can provide these services.
- Establishing the need for a road weather initiative since U.S. DOT has already made a large investment in aviation weather services. A convincing demonstration that surface transportation weather issues are significantly different from those of aviation must be made and coupled with support from stakeholder groups and involved federal agencies. The benefit-cost case must be compiled to convince key decision makers on the need for weather information/management systems. This is not unlike what is needed for a variety of ITS initiatives.

- Financial policy issues will need to address both private and public needs and capabilities. The private sector may not aggressively invest significant resources to develop a road weather services product line unless it can be shown that a solution is feasible and marketable. However, until a capability can be successfully demonstrated, the market remains uncertain. In many cases, the only way to determine the utility of a system is to build a functional prototype. If the feasibility and benefits of the prototype are demonstrated and the technology is made available to the public, open market forces will take over.
- Public funds need to be dedicated for weather research to address the micro-climate that exists at the road surface. Public funds are also needed to research methods to provide weather data quality assurance.

2. What opportunities are emerging and what impediments are in place that have impacted progress to date?

- The National ITS Architecture provides the opportunity and framework for integrating road weather services into Centers, Vehicles, Roadside and Travelers operations.
- New technology industries such as intelligent vehicle initiatives by the major automobile manufacturers will recognize the opportunity to include route-specific information that describes road and weather conditions in their value-added options. Auto industry/road owner partnerships may bring together roadway condition information gathered by vehicle probes that can be merged with other weather information sources to enable better winter road management.
- Lack of a road weather research program with a rapid prototyping component, and long-term relationship with the end users is a major impediment

3. What public policies are needed to foster effective application of weather services to the management of the nation's highway system?

- Endorsement of a proactive approach for dealing with weather and the transportation system to reduce casualties and improve system efficiency before gridlock becomes more widespread
- Establishment of a long term, multifaceted road weather research program utilizing a public-private-academic partnership approach focused on addressing user needs and extracting the scientific and technical capabilities that reside in organizations across the nation. The reauthorized Federal-Aid program needs to build the research needs into the RD & T funding.
- Partnerships across and among units of government within and across State boundaries to share information and practices.

Policy issues in implementing effective application of weather services to the management of the nation's highway system

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(Paper not submitted at time of printing.)

Policy Issues Affecting the Development and Application of Weather Services to the Management of the U.S. Highway System

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When properly integrated with highway system operations, advanced weather monitoring and forecasting capabilities offer the potential to save lives, avoid traveler delays, and improve the cost-effectiveness of highway maintenance expenditures. Fully realizing this potential will require sizeable research and development investments, and it will require well funded and well coordinated implementation programs.

Unfortunately, experience shows that great potential by itself is not enough to make investments of this sort happen in the highway field. Formidable institutional and financial barriers stand in the way, some of which derive from the way the highway system is organized in the United States.

- The U.S. highway system is incredibly decentralized. The system is owned and managed by the 50 states and tens of thousands of local governments of all types. This decentralization creates obvious challenges with respect to maintaining consistency across the system and to transferring new technologies into widespread practice.
- The public and our political institutions are reluctant to increase highway taxes dedicated for highway purposes so that they keep pace with the growth in demands on the system (e.g., increased traffic, increased environmental mitigation, requirements to maintain traffic during reconstruction, need for active system management). As a result, highway agencies have difficulty finding the funding to introduce new services and technologies.
- Public sector highway agencies are generally conservative and risk adverse. The potential rewards for successfully introducing new technologies can be easily offset by the risks of cost and schedule overruns and the attendant publicity and legislative reactions.

When funding is tight in the public sector, research generally suffers. If one judges by the level of research expenditures in relation to total expenditures, the highway industry spends much less on research than even “low tech” private-sector industries. One consequence is that there is a back-log of promising ideas that have either been under funded or not funded at all. So as promising as developing weather applications for highways may be, they are competing with other good ideas for research funding.

Implementing advanced weather systems will also face a number of financial and institutional barriers. The introduction of advanced traffic information systems (i.e., real time speed, delay, and incident information) might be instructive in this regard. As a first order approximation, there are many similarities between the two systems—both would produce benefits to users and system managers; both would be useful in real time but also would produce data that could be used for developing better models and forecasts; both face uncertainties with respect to revenue or funding potential; and both have alternative technology and communication options.

Although weather applications have been developed and applied over the past 15 years, particularly to snow and ice control, it is fair to say that the potential benefits of advanced weather systems are not widely recognized or well understood. This is not the case with traffic information systems—such systems exist today and the Federal Highway Administration and others have been supporting their development in the United States for some time. Yet so far, we have not found the right formula—technologies, institutional arrangements, and funding/revenue sources—to implement, or even develop an implementation program, that would make real-time traffic information available on all interstates and other major facilities. Some lessons this experience that might be applicable to the development and implementation of advanced weather systems include:

- Demonstrating the benefits of weather technologies should receive great emphasis. This would involve using existing technologies in experimental corridors or with “lead” state departments of transportation.
- Maintain a close connection in both research and demonstration activities to the problems that weather-related technologies will address and the constituencies that traditionally have addressed these problems. If the program is identified by the technology rather than the application, it may not garner the understanding and enthusiastic support that it will require to be successful.
- Reliance on the user financing through private-sector vendors can be problematic even if motorists and motor carriers will be direct beneficiaries of the services.

A Realistic Approach to Develop and Implement a National System To Provide Weather and Roadway Safety Information to the Traveling Public

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Introduction

The call for ideas to increase the utilization of weather information for greater safety in highway transportation is made again. The Department of Transportation's Federal Highway Administration (FHA) has been trying to stimulate the weather/ transportation industry (Federal Government, State Agencies, and American businesses) for over a decade. Each time a call is issued the weather research community quickly submits proposals for research projects, the operational weather agencies shy away, private businesses try to stretch their fee for services to the highway traveler, but don't reach the vast majority of vehicles and can't handle the necessary investments or the liability of a national program. Then the dust settles, time passes and not much really happens. After a while, the FHA makes another try by hosting another event and the maddening cycle repeats itself. This time there is a different threat that must also be considered in preparing for safety on the nation's highway- a security threat.

The National Weather Service for decades has issued weather warnings and traveler hazard advisories such as dangerous precipitation (snow, rain, and hail), icing potential, obstruction to visibility (fog, blizzards), high wind conditions, etc. NOAA Weather Radio (NWR) has also been available for decades, but is unavailable in most vehicles on our roadways. Traveling along our highway system it is virtually impossible for the public to get pertinent and timely weather and highway safety information.

Meanwhile, in the past decade the National Weather Service has completed a modernization and associated restructuring never before seen in scale and accomplishment. The ability to predict, detect and warn of severe weather has been improved greatly. Real time observational data and information pertinent to highway travelers' safety is available and can be distributed from Weather Service office servers in each state, but is not readily available where it is needed - in the vehicle. State and local DOT's, as a result of FHA's concerted efforts and the self interests of the states, have implemented a large number of roadside observing systems whose data is routinely available to those making maintenance and operational traffic management decisions. These data are also available to weather forecasters but the traveling public is mostly unaware of management decisions until the effects are encountered on the highways. Technology manufacturers forged ahead in the same period with novel and potentially effective tools to aid the traveling public, but these are not integrated with any real time weather or highway safety and security information. Automobile platform manufacturers have made quantum leaps in platform safety and technology insertion in the last decade. The majority of their fleets, however, offer virtually no integrated weather and highway safety and security information for the driver's use. The level of sophisticated operations in vehicular platforms has increased substantially and today (and more so tomorrow) technologies exist that are capable of providing a level of integrated operations that would bring unprecedented highway safety and security to this country. With all this pent up potential what is it we are waiting for?

Relatively simple measures can be taken to bring the life saving weather and highway safety and security information about existing threats into the command and control systems of the more advanced automobile platforms. This information can be presented to the vehicle operator in such a fashion that the resultant decisions and procedures initiated by the smart vehicle and driver would be integrated to achieve the most favorable response. The results would be unprecedented in their effect of reducing highway fatalities from weather hazards!

The next steps would be to introduce this integrated capability to the majority of the operating fleets over the next decades. Simple enough! How can these straightforward steps be achieved?

The Highway Transportation Security and Safety Program (HTSSP) is proposed as a national program to develop and maintain the security and safety of our national highways through a partnership of Federal,

State and local governments and American Businesses, employing state of the art “smart vehicles”, existing environmental and highway information and an educated driver community.

Motivations

The policy paper distributed for this forum suggests the use of the Aviation model for the initiation of a national highway weather safety program. Unfortunately, there are significant differences between the public attitudes surrounding highway and air transportation.

The airline industry has huge financial interests to encourage research and improved aviation weather products; their operational costs are directly affected by weather. The flying public has an innate fear of flying that encourages public endorsements of increased aviation research and improved safety even though they will have no direct involvement in the research, testing or implementation of any resultant changes introduced. The public may benefit from such improvements, but would be hard pressed to tell what efforts caused the improvements that have been implemented.

The highway traveler does not have the same innate fear as does the flying public. How could one be concerned over their safety while traveling in excess of 70 mph, and talking on his/her cell phone and simultaneously working their laptop or PDA device while only occasionally looking at where they are driving? They may have little experience in high speed vehicle braking or maneuvering in a cluster of vehicles, may have little or no awareness of an impending hazardous condition and, if they did, they may not know immediately what steps they should take to attain a safer operating environment.

Changes introduced in the aviation arena are done in a highly coordinated operational environment; pilots are informed of the procedural or operational changes planned and/or are given training in advance of the changes; similarly personnel at traffic control centers and towers are equally well prepared to implement operational safety or traffic control changes.

The highway transportation community does not share the same level of disciplined transition to improved operations. **A capability of disciplined transition is important to the long term success of the HTSSP.**

Creating a favorable public view towards the efforts and accomplishments of the HTSSP while simultaneously increasing the national fleet of smart vehicles and operating a uniform highway operations and maintenance program requires an educational program that is three pronged:

1. Create a public awareness and desire for greater highway safety (the “demand pull”)
2. Use the demand pull of the public to increase the marketability of these safety systems and competitive pressures on the vehicle manufacturers to participate fully in the program.
3. Institute a continual driver education program to promote public awareness of the growing national capability resulting from the success of the HTSSP.

The driver – smart vehicle- the data and information

A useful vision to employ: an informed driver, operating in a smart vehicle and a highway system managed for security and safety achieves unprecedented levels of highway safety.

The Driver

A cluster or group of vehicles traveling at high speeds is “safe’ so long as their relative speeds, directions of travel, and separation distances remain constant. Abrupt changes in these parameters as a result of hazardous weather, changing roadway or traffic conditions or inattentive drivers place the cluster at higher risk. The rapid closure of one cluster with another, for whatever reason, also raises the traveler’s risk. Moving at common highway speeds these clusters of vehicles require a minimum time to recognize, prepare for and properly respond to an impending safety threat.

An informed driver must be made aware of these changing life threatening conditions in sufficient time to affect the appropriate responses under the circumstances. Automotive safety features in smart vehicles must be operated in concert with the desired action of the driver.

The highway driver, on average, has little awareness of traffic management or operations affecting the roads they travel until they are encountered. Their driving experience is quite varied and most probably averages at the lower end of any overall proficiency scale. Thus how does one practically make highway system operational changes within an environment devoid of organized discipline to transitional change? A number of new capabilities and disciplines must be deployed.

The Smart Vehicle

The smart vehicle of today monitors in-situ temperature, pressure and humidity for routine operations. It can also detect precipitation and reduced lighting and turn on the windshield wipers or headlights. These actions would probably not startle the driver. In addition, it is capable of monitoring losses of traction on individual wheels and applying either braking or added torque to individual wheels to maintain lateral and longitudinal stability. In a panic situation the smart vehicle can stop the forward motion more rapidly and safely than the typical driver. The smart vehicle can also monitor and maintain separation distances between traveling vehicles. Just image what this smart vehicle could do if it knew that road surface frictional coefficients would change dramatically just two miles ahead, or if the driver and nearby cluster of vehicles would suffer dramatically reduced visibility or encounter large lateral winds or an unanticipated accident! Suppose the smart vehicle knew of these impending hazards to travelers and took some unannounced steps to prepare for them without informing the driver or the nearby cluster of vehicles. Imagine the instability between the driver- and the vehicle's automatic control system!

Changes introduced in automobiles are mostly implemented by the platform manufacturer for safety, performance, or financial reasons. Rarely is the broader public aware of new capabilities until they are introduced by the manufacturer and drivers frequently have difficulty in utilizing any but the most simple of features. In recent years, the driving public has had in-vehicle access to such advanced features as to telephone/ telecommunication capabilities (though most phones are carry on types and few are integrated into master control consoles), laptop computers, GPS navigational aids, SOS safety features, night vision assistance devices, vehicle spacing radars, vehicle assisted emergency braking and electronic stability control programs. The driver controls over some of these safety oriented capabilities are limited and the operation has usually been engineered to be almost completely unassisted. Platform manufacturers have a long and highly competitive process for introducing changes in the operation of convenience or safety features. Great care is given to the operability, performance and maintenance of the new feature. Concept cars, test /demonstration vehicles and limited fleets of equipped vehicles are employed to test and evaluate the concept, manufacturing process, cost/ benefit and marketability of the enhancements.

Platform changes can take from a few years to several platform life cycles (6-8 years typically) before successfully being implemented. More advanced features can take many years to permeate a whole fleet- if ever.

The Data and the Information

There is a significant need in our vehicles for timely and accurate **Data and Information for Driving Safety and Security (DIDSS)**. This includes observational data and information about life threatening weather events, highway traffic flow conditions and obstructions thereto and highway management decisions in effect for any highway segment. The DIDSS information called for must have a recognizable risk level and a perishable life time. Too short a lead time and the driver or cluster may panic or can't react safely; too long a lead time and the driver or cluster may set too low a risk level, get distracted or simply forget to take the necessary precautions for their safety. The likely nature and duration of the "threat" must also be inferred, i.e., is it a freezing bridge or accident 2 miles ahead or a hazardous condition existing for the next 20-40 miles?

DIDSS initially should include existing observational data and information about weather elements hazardous to highway travel plus traffic flow and highway management information that are needed by the smart vehicle and

driver. The **vehicle must provide the driver this information**, in some manner, as well as any vehicular operating adjustment being made. Additionally, DIDSS can provide near term route planning information in the event of extended periods of reduced traffic flow, highway construction or maintenance activities.

Each platform manufacturer will determine how to implement the essential capabilities prescribed by this paper to achieve the desired smart vehicle. The method of implementation may vary between manufacturers. ***The information provided to the driver regarding the impending weather threat or highway conditions and the expected driver response to this information must have some commonality between the different platform manufacturers.***

HTSSP Objectives and the Transition

Realistic objectives can be established for the Highway Transportation Safety and Security Program for two consecutive decades.

In the **first decade** the Program should:

1. Focus on real time existing weather hazards,
2. Seek to use existing weather information,
3. Implement the DIDSS system infrastructure across the country in concert with vehicle platform manufacturers and technology providers,
4. Introduce a uniform set of nationwide security and safety highway management procedures consistent with evolving platform capabilities and driver educational programs,
5. Begin an effective driver education,
6. Target 80% on all vehicles introduced in this period to be provided with no less than a basic set of capabilities.

In the **second decade** the Program would seek to introduce improved observational data and mesocale weather information consistent with the appropriate intelligent vehicle and highway management capabilities.

Transition

The transition from today's condition of driver knowledge, vehicular capabilities and available highway data and information to the targeted goals for the first decade of the HTSSP should employ a multi path approach:

1. **Data and Information Structure:** A DIDSS national grid structure and an overall approach for the distribution of DIDSS information must be established. It is useful to consider a DIDSS uniform nested national grid. The grid dimensions could be on the order of 25 miles on a side; each box could have the capability for higher resolution data and information of perhaps 10 and 2.5 mile sub-grids scales. Each grid box would have a unique numbering identifier. Existing data and information would be packaged for the appropriate location depending on the scale of the weather threat or roadway condition at hand.

A corollary action on the part of the platform and technology manufacturers would be to ensure in-vehicle technologies are capable of recognizing the vehicle's location at any point in time and ensuring that the appropriate addressed message is received and presented in the vehicle.

A national policy requiring the in-vehicle capability to receive NWR information needs to be considered. This would provide the most basic level of weather information to the motoring public. Currently VHF frequencies are utilized in NWR, but selected channels of the AM broadcast band (e.g. 550 MHz or 1550 MHz) could be set aside for national highway safety and security information. This would have the added advantage of making NWR information available to all AM radios in homes as well as vehicles and extend the effective range of the transmissions.

2. Data Collection and Dissemination: It is necessary to establish a national data and information collection and dissemination infrastructure. A variety of weather data and roadway information is available from multiple sources. The NWS office in each state has available the majority of observational data and information pertinent to the weather conditions in that state. Roadside observational data is collected by State DOT's that is or could be made available to the NWS, and private weather providers, that also may be pertinent to the traveling public. How will the data be collected and made available to each vehicle? A model worthy of consideration is that of **roadside kiosks** that can disseminate data over a few miles and, in some instances, collect selected data.

The existing roadside observing systems deployed by many states could serve an additional function. With modest investments of existing technologies DIDSS Kiosks could be established. These Kiosks would serve the function of collecting supplementary weather and roadway information and sending DIDSS information to passing vehicles. Select long haul carriers can provide invaluable information to verify weather and roadway conditions as they move about the country. The operators of these vehicles could manually set indicators of certain highway conditions such as obstructions to visibility, icing, accidents, etc. which along with GPS positional information can be telemetered to roadside kiosks for relay to management control centers and weather information providers.

Transportable Information Pods (TIPS) could be utilized for temporary site-specific roadway situations such as bridge or road segment repair, flood damage, etc. and would transmit limited information to passing vehicles. This would also be useful for alternate route planning by the vehicle operators.

An alternative approach worth considering is the National Weather Services' NOAA Weather Radio (NWR) selective encoding capability. Each county and eventually sub parts of a county are identified with a unique number identifier. Products sent out via NWR are tagged with the specific identifier number of the county for which they are intended. Radio receivers can be programmed to accept products designated for any one, multiple or all counties. It is technologically possible for digital warning information to be appended to NWR messages, making this existing system worthy of consideration for deployment of DIDSS at low incremental costs.

3. Design and implementation of a phased driver education program. The existing driver population needs to be made systematically aware of and interested in the HTSSP, its benefits and its evolving accomplishments. This education program should create the demand pull and motivation needed by platform manufacturers. The current driving populations and each successive generation of drivers must be reached.

The education program should evolve in concert with the evolution and implementation of the HTSSP. Novel techniques should be employed to pique and sustain interest and awareness. (Remember Burma Shave roadside jingles?). In- vehicle CD based mini lessons could be developed, tested and made available for free to the public.

4. Uniform command and Control: A uniform national highway command and control system compatible with the concept of the HTSSP needs to be established and made known to the public. Much of this may exist today but there still remain variances in individual state and local municipalities' practices. Management and traffic control decisions need to be available to the driver.

It's time take action to improve highway transportation safety and security from environmental and security threats. Options exist to begin a rapid and organized deployment of required capabilities. Automobile manufacturers possess the in-vehicle technologies to begin an organized transition. A national data and information collection and dissemination infrastructure can be quickly established at marginal incremental costs. The driving public is in need of a continual driver's education program to increase their personal awareness, safety and security on our nation's highways.