

NIGHT ICING POTENTIAL PROJECT - Thermal Mapping

Introduction

You're driving to work at 6 am on a cold February morning. It's not snowing or raining and the roadway appears dry. You're rounding a gentle curve and suddenly you lose control of your vehicle. Your heart is pounding as you do a 360° turn and end up sliding into the snow filled ditch. You're thinking how lucky you are there was no traffic coming from the opposite direction. That would have resulted in a nasty accident.



What happened? This is a classic case of black ice; that invisible, yet treacherous, condition that occurs when moisture from the air condenses on a sub-zero pavement surface and freezes. Because it contains relatively little entrained air in the form of bubbles, black ice is transparent and thus very difficult to see on the black asphalt roadway.

Some people extend the definition of black ice to water sitting on the roadway which freezes due to a rapid drop in the air temperature, but for our purpose we are concerned with ice that occurs when the roadway appears dry, yet water from the air condenses and freezes on the roadway.

Bridges and overpasses can be especially dangerous. Black ice forms on these surfaces because air can circulate both above and below the surface of the elevated roadway, causing the pavement temperature to drop more rapidly.

Road Safety is severely compromised by the presence of black ice. The Nova Scotia Department of Transportation & Infrastructure Renewal (NS TIR) completed a pilot project in early 2007 which provides the front line highway maintainers with a unique tool with which to fight the dangerous condition of black ice formation. After the 43 km pilot project was deemed successful the Department has expanded it to capture data on a further 250 kms of roadway.

Nova Scotia's Suite of Winter Safety Systems

The Province is very well covered with Road Weather Information System sites, 40 in all and the Department contracts a private weather forecaster to predict winter storm events so that our road maintainers can take action at the outset of weather events, that time when most accidents occur. All of these sites have cameras which allow travelers and truckers to view real time road conditions before making their decision to venture out on the roads during inclement winter weather.

The public can also access timely graphical reports on winter road conditions through the Department's web based Road Condition Reporting System (RCRS). The RCRS also serves as the data source for Canada's first 511 Traveler Information line. Again, these tools facilitate the decision to travel for the public.

This entire suite of systems combines to allow our highway maintainers to make winter roads safer and enables the traveling public to make well informed decisions prior to any travel in inclement winter weather.

Thermal Mapping and Road Weather Information Systems (RWIS)

Thermal imaging of roadways using infra-red (IR) sensors was first developed about two decades ago. IR sensing has been used to quantitatively describe the thermal behavior of a roadway at night under various weather conditions along its entire length. The diagrams produced are generally referred to as thermal fingerprints. As more roads in an area are 'fingerprinted', a two-dimensional thermal map for an entire road network, or part of it, can be produced.

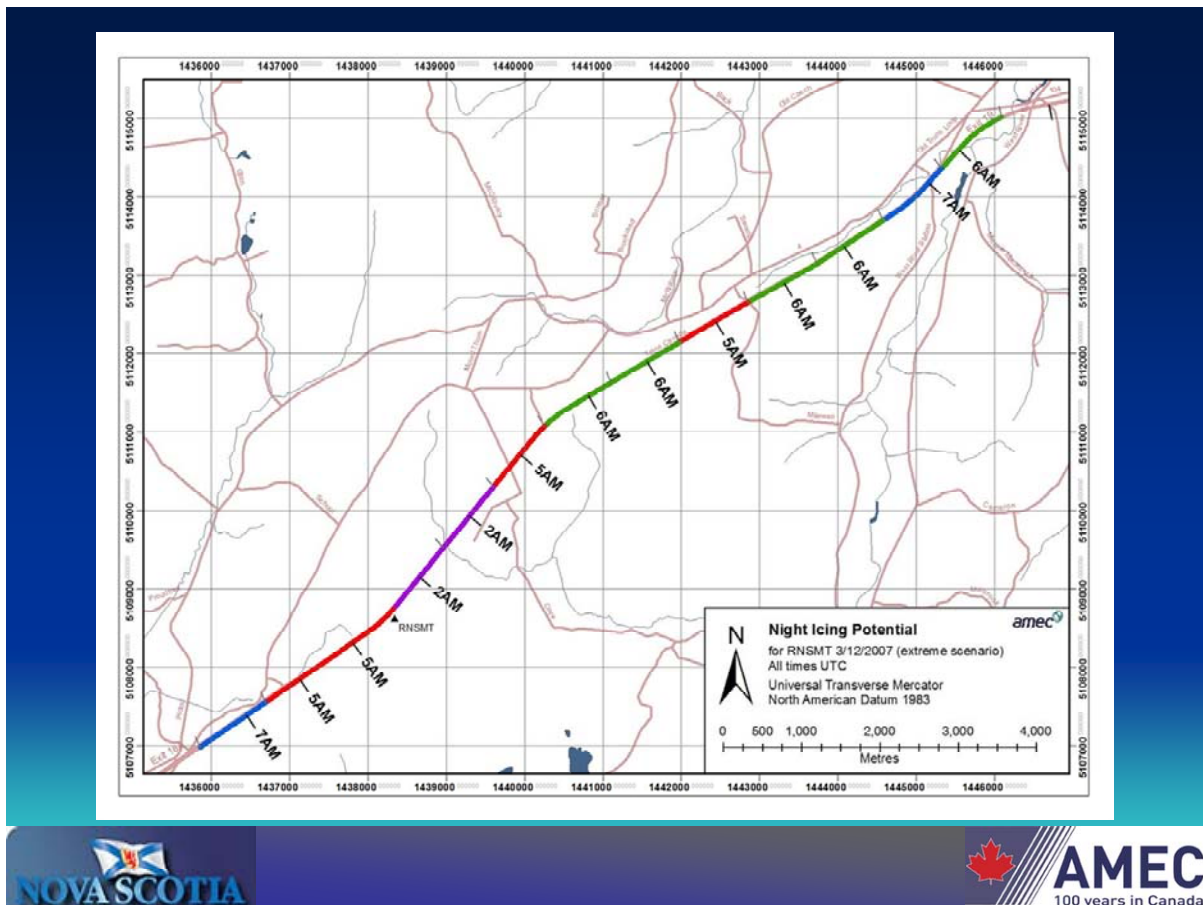
Road Weather Information Systems (RWIS) monitor atmospheric and pavement conditions at a single point and forecasts future road surface temperature and condition which provides a solution only at the RWIS locations. Thermal fingerprints provide a means of determining which road segments are colder or warmer than its associated RWIS site and can be used to forecast pavement temperatures along the entire length of the roadway at night.

Using RWIS data and forecasts together with thermal fingerprints provides a means of determining where along a roadway surface temperatures may drop to below 0° Celsius over the coming night. With early morning relative humidity values in excess of 97% on virtually all nights, one can then assume a high likelihood that frost will form on those sections of roadway where road surface temperatures dip below freezing. Specifically, road surface temperature must drop to below freezing and the road surface temperature must be below the air dew point. To forecast where and when frost will form, if at all, one must determine where and when road surface temperatures will meet these two conditions.

Night Icing Potential Pilot Project

In 2007, NS TIR contracted AMEC Earth & Environmental to perform a thermal mapping pilot project. AMEC used infra red sensors on data collection vehicles to develop Thermal Fingerprints for the western half of Trans Canada Highway 104 in Pictou County. Thermal Fingerprints were developed for each of the three classic weather types: Extreme, Intermediate, and Damped.

The Night Icing Potential (NIP) prototype was developed as a new operational guidance product for use by winter maintenance operators. NIP uses RWIS forecasts together with Thermal Fingerprints of a roadway to assess the potential for night icing anywhere along the entire length of a roadway. NIP returns the earliest time for the onset of the icing process for each kilometer-long segment of roadway where a night icing potential exists. The product is presented in map form with the icing times plotted along road segments which are also colour-coded according to icing onset time. See figure below.



Night Icing Potential – Next Steps

The Nova Scotia Transportation and Infrastructure Renewal (NS TIR) is currently performing data collection for a Night Icing Potential (NIP) service for major Nova Scotia highway approaches into the Metro Halifax area (highways 101, 102, 103, 107, 111, 118), part of Highway 101 in Kings County and Highway 125 near Sydney, Cape Breton.

AMEC will develop and provide a single integrated NIP map service encompassing all of the selected routes for NIP service in the Metro Halifax area. They will also provide the NIP map service for Kings County and Cape Breton. This single integrated view would be extremely valuable for collaborative decision making and shared situational awareness for winter road maintenance personnel.

This new NIP service is intended to provide valuable assistance in the decision making process with regard to the road maintenance activities in response to potential roadway icing, a particularly insidious winter road hazard. The service should also provide environmental and cost benefits to the road maintenance organization.

Conclusions

The Department believes that the NIP service is a very valuable tool in the battle against the insidious hazard of black ice. It enhances our ability to make our roads safer in the treacherous winter months.

NIP also enhances the usefulness of the Province's 40 road weather information sites by allowing us to relate pavement temperatures at the RWIS sites with pavement temperatures along long stretches of roadway between the sites.

In addition Nova Scotia has a state of the art road condition reporting system which contributes to winter road safety by keeping the Public apprised of winter road conditions and summer construction through the use of a website, and also having the information available on the first 511 Traveler Information line in Canada.