

CHAPTER 9: TEMPERATURE SENSORS

Pavement temperature is the critical measurement for applying chemicals and abrasives in snow and ice control operations. The pavement surface is where chemical reactions occur as salt or other chemicals are applied to melt ice or snow pack, and pavement temperature greatly influences those reactions. Real-time pavement temperature data can therefore help snowplow operators make efficient decisions about the kind and amount of material to spread on the pavement. Air temperature is only secondarily important. Depending on other atmospheric conditions (e.g., the amount of sunlight, wind, humidity, etc.), air temperatures may forecast changes in pavement temperature.

In Phase II, the study team's goal was to observe if pavement and air temperature sensors, similar to other environmental sensors used in agricultural applications, could be installed on winter maintenance vehicles and provide real-time data to vehicle operators to help them continually refine their maintenance operations. In later phases, the study team plans to carry this concept a step farther. The onboard temperature sensors will provide input directly to other logic systems on the maintenance vehicles, which will react to changing temperature values with programmed responses. For example, the temperature sensors will provide real-time pavement temperatures to the material spreader system. If pavement temperatures fall below freezing (32° F), the chemical and abrasive spreader system will select the materials and application rates appropriate for the recorded temperature and automatically dispense the materials. For this kind of interoperability to be effective, the air and pavement temperature sensors will require a very high degree of reliability and accuracy. In Phase II, therefore, it was critical to determine that the temperature sensors were collecting reasonable data. A controlled field evaluation of temperature sensor performance will be conducted in Phase III.

Sprague Controls, Incorporated, of Canby, Oregon, provided a Sprague RoadWatch Temperature Indicating System (RoadWatch) , RW1, 600 Series, for each of the three prototype maintenance vehicles to monitor pavement surface and air temperatures.

OBJECTIVE

Conduct proof of concept regarding using sensors on a winter maintenance vehicle to automatically collect air and pavement temperature data.

MEASUREMENT

The RoadWatch system is successfully installed on the prototype vehicles and operates as expected; that is, the RoadWatch system collects reasonable air and pavement temperatures.

DISCUSSION

RoadWatch is a passive infrared temperature indicator that uses infrared technology to translate surface energy into a temperature reading. For road surface temperatures, an infrared sensor absorbs heat energy from the road surface through a small lens on the bottom of the sensor, converts that energy into an electrical signal, sends the signal to a processor in the vehicle cab, and converts the electrical signal to a temperature display. The process is similar to a light meter in a camera that absorbs light energy and converts it to an electrical signal; the pavement surface temperature sensor absorbs heat energy and converts it to an electrical signal.

The RoadWatch temperature indicating system consists of the infrared sensors, the in-cab processor and display, and a shielded cable connecting the sensors to the display. The in-cab display shows the air temperature (at the top of the display) and the road surface temperature (at the bottom of the display). The display also has a small beeper and a warning light that are activated when either temperature cools to 35° F. The infrared sensors were mounted without difficulty on the driver's side-view mirror as shown in Figure 9-1. The two-inch digital gauge is mounted in the vehicle cab. The road surface temperature range is -40° to +200° F, and the air temperature range is -40° to +120° F. Its manufacture-stated accuracy is plus or minus one percent of full scale, or 1° F. The response time is 1/10 second. The RoadWatch pavement and air temperature readings are collected on the Rockwell PlowMaster system.



Figure 9-1 RoadWatch, Iowa prototype vehicle

Comparing Sensor Data to RWIS Data

The nearest Roadway Weather Information Systems (RWIS) site to the Iowa route is located on I-235 near downtown Des Moines, on the Des Moines River bridge. This RWIS site is approximately eight miles from the closest point on the route and represents a very different environment from the route. Therefore, comparing the temperature data collected by the concept vehicle on the test route to the data collected at the RWIS site located eight miles from the route is not appropriate.

Temperature Sensor Test and Evaluation Done by Other Investigators

Braun Intertec Corporation, Portland, Oregon, an independent testing and engineering consulting firm, issued report 05-047-1007 reporting results of project EARX-97-0270. The report provides results of a comparative performance test conducted with Control Products 996A and a Sprague RoadWatch surface temperature monitoring system. Report 05-047-1007 is included in Appendix H. The results of this evaluation point out that the RoadWatch temperature sensor is capable of collecting road and air temperature.

Observations Made by Iowa Maintenance Area Supervisors

Proof of concept for the RoadWatch on Iowa's prototype vehicle has been conducted regularly since the sensors were installed. The vehicle is stationed at the Des Moines North shop. Lance Starbuck, Iowa DOT Des Moines North Area Supervisor, and Charles Pickett, Iowa DOT Des Moines West Area Supervisor, have observed readings taken by the RoadWatch sensor. Both supervisors were asked about the roadway temperature sensors and their correlation with RWIS and other pavement temperature sensing devices they use.

To more fully understand this new technology and build his and his operators' confidence in its reliability for use in snow and ice control operations, Lance Starbuck regularly monitored the temperature sensors' accuracy. He followed Iowa's prototype vehicle during snow removal operations and compared its RoadWatch readings with readings from the Control Products temperature sensors mounted on his pickup. Mr. Starbuck found the RoadWatch sensor to be within 1° F of the Control Products sensor.

Charles Pickett has checked both RoadWatch and Control Products sensors mounted on his pickup at two RWIS sites in his maintenance area. Mr. Pickett found that the RoadWatch sensor temperature readings typically run 2° F colder than RWIS, and readings from the Control Products sensor runs about 1° F colder than RWIS.

Because of its satisfaction with the Sprague RoadWatch, in the past year the Iowa DOT has installed about 100 RoadWatch sensors on a variety of snowplow and supervisor trucks.

OBSERVATIONS

Proof of concept was successful. The RoadWatch sensors were successfully installed on the prototype maintenance vehicles and, based on temperature sensor testing and evaluation performed by other investigators and observations made by Iowa DOT maintenance area supervisors, the sensors collected reasonable data.