Roadway Weather Information Systems (RWIS)

Roadway Weather Information Systems (RWIS) are becoming familiar sights along the highway as their use in identifying hazardous driving conditions expands both in the US and abroad. Ice or water on the pavement, low visibility, and high winds are all examples of hazardous conditions that RWIS can bring to the attention of transportation personnel and the public. The availability of this information can be invaluable to transportation personnel in managing their winter de-icing duties, and in monitoring trouble spots along roadways.

For an RWIS installation to be successful, three elements must be taken into consideration:

- The appropriate sensors must be selected
- The RWIS must be properly sited and installed
- The RWIS must be properly maintained

Sensor Selection

An RWIS system's sensor array can be a simple one consisting of standard sensors providing basic information--such as air temperature, wind speed, wind direction, ground temperature, and subsurface temperature(s), or it can be a very sophisticated one capable of measuring more complex parameters such as visibility and present weather. When choosing RWIS sensors, one has to take into consideration the strengths and weaknesses of different sensor models, and weigh the importance of those differences as they apply to a particular site.

Common RWIS Sensors

RWIS systems will nearly always include sensors to measure wind speed and wind direction, either in the form of combination sensors that can measure both speed and direction, or as individual wind speed and direction sensors. A very common and familiar type of wind speed sensor is the three-cup anemometer, which uses an arrangement of horizontally-mounted cups to sense wind speeds. As the wind turns the cups, this movement is converted to an electrical signal that can be read and converted to wind speed by the RIWS computer. There are many different types of anemometers, which can be different in appearance, but the basic principles of operation and reporting--converting wind movement to an electrical signal--are the same.

A well-built and properly located and installed anemometer will report wind speed very accurately within the limits of the sensor. The prices of these sensors can vary greatly, and as the price changes so do their functional characteristics. Threshold and resolution are two key specifications to consider when selecting an anemometer. Threshold refers to the wind speed required before a sensor can take and report a reading. With three-cup anemometers, this is the amount of wind required to begin turning the cups. Resolution refers to the minimum unit value that can be reported. (The displayed resolution of an anemometer will often be a function of the controlling computer and software as well as of the sensor itself.) A good anemometer may have a threshold of 0.5 miles per hours (0.8 kilometers per hour) and a resolution of 0.5 miles per hour. A low-priced anemometer might more typically have a threshold of 2 miles per hour and a resolution of 1 mile per hour. If very precise measurements are required, the low-priced anemometer will not serve the purpose. The key here is to knowing what resolution and thresholds are genuinely needed for your application, and then purchasing and installing correctly.

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Another nearly universal RWIS sensor are the air temperature and relative humidity sensors. These sensors are critical for predicting or detecting conditions where frost may appear on road surfaces. Typically, a single sensor provides both air temperature and relative humidity measurements. To minimize temperature measurement errors induced by solar heating, the sensor is typically mounted in a solar radiation shield. Two types of radiation shield are commonly available: Self-aspirated radiation shields (SARS), and motor-aspirated radiation shields (MARS). Motor-aspirated radiation shields provide greater accuracy of temperature measurements under all ambient conditions than do self-aspirated radiation shields.

Pavement sensors are used to determine road condition, a critical function of RWIS systems. Pavement sensors report the road surface as wet, dry, or frozen, and normally report road surface temperature as well. A common approach used in these sensors is monitoring of road surface conductivity, which changes as road surface conditions change. Where anti-icing chemicals are in use, surface conductivity is also an indication of the concentration of anti-icing material on the roadway. The presence and concentration of anti-icing material is vital information, since it will affect the actual freezing temperature of the road surface.

Visibility sensors measure meteorological optical range (MOR), and can be extremely useful in low-visibility, fog-prone areas. Knowledge of low-visibility conditions allows drivers to evaluate and possibly change their travel plans in order to avoid stressful and potentially hazardous driving situations. Visibility sensors used for RWIS typically use infrared forward-scatter technology. One limitation of these sensors is that anything in the optical path that attenuates or scatters the infrared light beam--such as dirt, spider webs, and so on--may cause erroneous readings. A cure for this problem is the four-headed type of visibility sensor, which provides essentially two sensors in one, a built-in check against such contamination errors.

Other sensors, such as ground temperature and solar radiation sensors, are very common in RWIS systems, especially where pavement forecasts are to be generated. A variety of these sensors is available, and they must be chosen, as all RWIS sensors must, with a careful eye to the precise use to which they will be put and the conditions under which they will be expected to function.

Site Selection

Correctly choosing the best location for the installation of an RWIS site can, and usually will, spell the difference between success and failure. An RWIS installed at a poorly chosen site can be the cause of incorrect sensor readings, servicing difficulties, and even damage to the system (from snow-blast, for example, when an RWIS is installed too close to the path of snow removal equipment). Power and telecommunication requirements also must be taken into account during site selection. All too often, a poorly chosen site leads to costly installation charges. On the other hand, an RWIS installed at a well-chosen site will provide continuous, reliable service with little attention.

The importance of site selection can be illustrated by showing some of the common site-specific problems to which common RWIS sensors are susceptible.

When mounting an anemometer, for example, it is critical that it not be sheltered from the wind, thereby giving readings far below actual conditions. At the same time, it should not be mounted too close to the roadway where wind from traffic will give inaccurately high readings or show ostensibly gusty conditions where they do not exist. Flying snow from winter maintenance operations could also damage or destroy the sensor if it is mounted too near the roadway. Other factors, such as height of the sensor above the ground and orientation, can also affect sensor readings. A quality anemometer manufacturer or RWIS supplier should supply detailed instructions on locating and installing the sensor.

Pavement sensors should normally be placed just outside the wheel path of vehicles, at a location that is known to freeze early. Locating the sensors at these places will provide information on road surface changes when they are most critical--at the beginning. Areas that tend to freeze first include pavement shaded by trees, overpasses, and bridges.

Ground temperature sensors should be located directly under a pavement surface sensor at the depth recommended by the forecast model, and solar radiation sensors should be located in an area that is representative of the radiation exposure of the road surface.

RWIS Maintenance

Many RWIS sensors, and most RWIS computers, have built-in test functions to alert the user to possible problems. In addition to these built-in tests, many common sensor problems can be identified quickly using fairly simple troubleshooting techniques.

A simple way to detect possible anemometer problems, for instance, is by knowing the ratings of the instrument, and comparing these numbers to reported values. For example, if the threshold of an anemometer is 0.5 miles per hours (0.8 kilometers per hour), readings in this area should be fairly common. Knowing this is important, so that one can watch the numbers on the reported data closely. If the threshold of the reports is suddenly never below two miles per hour (3.22 kilometers per hour), for example, this is an indication of a problem and the anemometer should be tested and repaired. Other simple wind sensor checks include turning the mechanical elements (such as cups or vane), and checking that the movement is smooth and that values displayed during the test show regular, even changes.

The performance of temperature and relative humidity sensors can be easily checked in the field by comparing reported values to those measured by a sling psychrometer. A sling psychrometer is a very simple instrument consisting of two accurate mercury thermometers, one of which measures wet bulb temperature, and the second dry bulb temperature. The measured dry bulb temperature serves as a check of the air temperature sensor, and the comparison of the wet and dry bulb temperatures provides a check of relative humidity. Dew point can also be calculated from the wet bulb and dry bulb readings, and provides an additional check. Dew point should always be equal to or less than the air temperature, so if the calculated dew point is greater than the measured ambient temperature, something is clearly wrong.

Pavement sensors can be tested by exposing them to water, salt solutions, or ice and observing the reported results. The sensor's surface temperature output can be verified by the use of a hand-held infrared temperature sensor.

Some visibility sensors have extensive built-in-test functions that will detect and report most sensor faults. Additionally, if a visibility sensor reports low visibility under conditions of high visibility, the optical path of the instrument should be checked for spider webs or any other debris that may cause scattering of the light beam. As explained earlier, anything in the optical path of the sensor that attenuates or scatters the infrared light beam may cause erroneous readings. Fortunately, it is relatively simple to inspect and clean the optical path of these sensors.

If ground temperature readings are suspect, they can be verified simply using a separate ground temperature probe

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Maintenance Plans
Any system will require maintenance at some point, and it is critical that the buyer decides on a maintenance approach early in the project. There are three basic maintenance plans, which should all be supported by any RWIS provider:

Option 1. The RWIS supplier trains the user to maintain and repair the RWIS down to the Lowest Replaceable Unit (LRU) level. With this option, a store of replacement parts is generally kept by the user so that failed parts can be swapped out as required in the field, and the failed parts returned to the manufacturer for replacement or repair.

Option 2. Maintenance and repair is performed by a vendor-approved and trained third party service organization. The service organization should receive strong support from the RWIS vendor, and have the necessary tools available for diagnosing RWIS problems remotely and on-site.

Option 3. The RWIS vendor performs all preventive and corrective maintenance. The RWIS vendor should have remote diagnostic capabilities, so that a problem can be traced and the parts required to correct it identified before a technician is sent into the field.

Putting It All Together
A successful RWIS program will depend on the careful coordination of these three essential areas. To assure that success, keep these guidelines firmly in mind throughout the development and implementation of your RWIS plan:

- When specifying the RWIS sensors, determine exactly what you need and to what accuracy. To go beyond your needs in terms of sensor accuracies, thresholds, and so on only serves to drive the price up.
- Once the sensor specifications and requirements are known, conduct a site survey to determine the optimum site for RWIS installation. During this site survey the availability of power and telecommunications at the site and the suitability of sensor locations need to be addressed.
- Finally, develop a plan for long-term support of the RWIS throughout its life.

With these essential areas carefully considered and addressed, an RWIS system will provide years of valuable and reliable service, and years of safer driving.

As an established manufacturer of high-quality weather monitoring products with a wide range of available sensor choices--up to and including complete RWIS systems--Qualimetrics, Inc. of Sacramento, California can advise you and provide the right solution for your RWIS application. Often times, changes in product specifications are confused with changes in quality of the product. All Qualimetrics products are fully guaranteed, and quality is never compromised anywhere within our complete line of sensors and systems.

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