Intelligent Transportation Systems Construction Engineering and Inspection Training, for Road Weather Information System

Module 1 Overview

Welcome

Welcome to the Intelligent Transportation Systems Construction Engineering and Inspection Training, for Road Weather Information System, Module 1 Overview. This training contains audio, so please adjust your speakers accordingly. This CBT contains interactive elements. An alternate version is available on the resources page. The Knowledge Check questions allow you two chances to try and answer the question correctly. To begin, select the start button or press Shift + N on your keyboard.

Purpose

This training was developed to show Construction Engineering and Inspection Firms what a Road Weather Information System or RWIS is, what it does, how it is commonly used on transportation projects, how to inspect an installed RWIS unit on FDOT ITS projects, and how to ensure that the Contractors have provided an approved and properly configured device.

You will be able to apply this training based on differing conditions in the field. However, not all FDOT ITS projects will deploy the same sensors. Some projects may require specific sensors for the weather conditions prone to the area.

Road Weather Information System

This training will also cover terminology, standards, basic inspection, testing and documentation that is needed before final acceptance, as well as other requirements that are relevant to a Road Weather Information System, and what to look for to make sure the RWIS is acceptable and properly installed on a FDOT project.

What is RWIS and Why do we use it?

Road Weather Information Systems are used by Regional Transportation Management Centers, or RTMCs, to monitor weather conditions on various freeways, arterials and express lanes. Closed-circuit television cameras are also used to observe the severity of the conditions. The information gathered by the RWIS is conveyed to the motorist via Dynamic Message Signs, Highway Advisory Radio and Florida 511.

The main purpose of RWIS is to convey weather-related hazards to the RTMC operator. When the operator receives an alert from the RWIS via SunGuide, an event is created and logged. The Florida Highway Patrol will verify the roadway conditions such as heavy fog as well as flooding caused by heavy rain. Imminent heavy fog conditions are a common hazard along Florida roadways. Northern Florida is prone to subfreezing conditions with the formation of ice on bridge structures. Additionally, high-profile vehicles are exposed to strong winds when travelling over high bridges and overpasses.

FDOT Developmental Specifications

The RWIS requirements are stipulated by the FDOT Developmental Specification, Dev688.

Developmental Specifications are specifications developed around a new process, procedure, or material approved for limited use by the State Program Management Office. These specifications are signed and sealed by an FDOT Professional Engineer responsible for authorizing their use and monitoring their performance in the field. FDOT Developmental Specifications can be accessed online. A link to the site can be found on the resources page.

Other Industry Specifications

The RWIS shall support the National Transportation Communications for ITS Protocol or NTCIP, Section 1204.

The applicable NEMA Standards involve the durability of the electronics when they are subjected to environmental extremes. There are procedures described in NEMA TS2, Sections 2.2.7, 2.2.8, and 2.2.9, that must be followed. The equipment is typically tested by a third-party facility. Evidence that the equipment has passed these tests should be submitted.

NFPA 70 is the National Electrical Code, also known as the NEC. These guidelines should be followed when the equipment is being installed.

NFPA 780 describes guidelines for the installation of lightning protection systems.

Various UL Standards must be followed as well.

FDOT Developmental Specifications

When you select the link to the FDOT Developmental Specifications, scroll down the list to Traffic Control Devices and you will find the RWIS device specification there.

During the design phase, the designer must contact the FDOT Monitor and provide notification of the proposed project. The FDOT monitor is a licensed FDOT Professional Engineer overseeing the establishment of the Developmental Specification. Once the FDOT Monitor approves the project, the project number will be listed in the Project List.

Check the Project List to see if your project is shown.

What is the Innovative Product List?

The Innovative Products List or IPL, identifies the products under consideration by the Department for use in conjunction with Developmental Specifications, Developmental Design Standards, and the draft language in other Department documents. These innovative products may be used on the State Highway system but need to be evaluated under actual field conditions.

The IPL is not exclusive. The Contractor may request consideration for alternative products. The use of any of these developmental or draft documents, IPL products, or alternative products must be approved by the FDOT Monitor, District Departmental staff, and the Construction Engineering and Inspection personnel. The Innovative Products List link can be found on the resources page.

Components of the RWIS

The RWIS is comprised of various sensors and a remote processing unit or RPU.

The sensors collect the following types of data: the ambient air temperature, pavement temperature, relative humidity, barometric pressure, precipitation data – including type and intensity, visibility as affected by fog, smoke, or a combination thereof, and wind data, including direction, average speed, and gusts.

It should be noted that, depending on the RWIS location, not all of the different types of sensors will be deployed.

The RPU is capable of storing and transmitting the sensor data to the RTMC.

Description of Sensor Data

The following provides a brief description of each type of sensor data:

The **ambient temperature** of the air is something with which we are all familiar. This is similar to the temperatures reported by meteorologists in daily weather reports, and what we feel when outside.

Pavement temperature is the temperature of the surface of the roadway pavement. Air temperatures are not usually good indicators of what the roadway surface temperature actually is. During the fall, the pavement is often kept warmer than the surrounding air because of the warm soil. Bridge deck temperatures during the winter are occasionally colder than the surrounding air temperature.

An important consideration in knowing the difference between pavement and air temperature is the formation of Black Ice, occurring when the air temperature is below freezing but warmer than the pavement temperature. This condition can cause moisture to rapidly freeze and create a thin, transparent layer of ice on the roadway. Black Ice is also more prevalent on bridges since cold air passes under and above the bridge and makes it freeze easily.

Relative humidity is the amount of water vapor present in air expressed as a percentage of the amount needed for saturation at the same temperature.

Approaching storms and wind cause **barometric pressure** to decrease. Rising pressure indicates fair weather. The longer it takes barometric pressure to change, the longer the coming weather pattern can be expected to last.

Precipitation measurements include the type as well as intensity. Rain, snow, fog, drizzle, and hail are examples of precipitation types. Intensity can range from trace to a heavy downpour.

Visibility sensors offer continuous high-speed sampling measurements taken during mixed weather such as rain and hail, while providing reliable readings during more stable events such as fog and mist. Visibility sensors also provide valuable measurements for smoky and smoggy conditions.

Wind sensors measure speed and direction. Modern ultrasonic sensors can capture speeds of up to 200 miles per hour. Both the average wind speed and gusts are collected by the sensor and sent to the RTMC.

Description of Data Flow

The FDOT Developmental Specification 688 describes a system that transmits the weather data via satellite to interested agencies. The system utilizes an RPU that collects data from various sensors and compiles the data into a format for satellite transmission.

More recently, the RWIS stations have been deployed within reach of the FDOT communication network. The proximity of the station to the network allows the sensors to be directly connected into the managed field ethernet switch. Once the sensors are connected to the FDOT network, the data is accessible at the FDOT RTMC.

Sensor – Air Temperature, Relative Humidity, Pressure, Precipitation

Modern sensors can capture an array of environmental parameters. For example, the sensor shown on this slide can measure the following: air temperature, relative humidity, air pressure, precipitation intensity, precipitation type, and precipitation amount.

According to Developmental Specification 688, the temperature sensor should be able to measure temperature with a tolerance of ±1° Fahrenheit, between -40° Fahrenheit and 176° Fahrenheit; with resolution of 0.1 degree.

The relative humidity has a tolerance of ±5% between 10% and 10%.

The precision for pressure is ±0.02 inches of mercury and between 27.2 and 31.9 inches of mercury with a resolution of 0.005 inches of mercury.

Precipitation can be classified as one of three types: light rain, rain, and ice. Its intensity ranges between 0.02 and 200 inches per hour.

Sensor – Pavement Temperature

The current Developmental Specification 688 does not address pavement temperature. As a result, the contractual document should specify the pavement temperature measurement if this feature is desired.

There are two types of pavement temperature sensors. They differ in installation methods. Apart from measuring pavement temperature, they each have additional unique features.

The Non-Invasive sensor is mounted on poles, offset from the roadway. These are able to detect road conditions such as dry, moist, wet, ice, snow, critical wet, chemically wet, and road surface temperature, ambient temperature, water film height, dew point temperature, relative humidity, ice percentage, freezing temperature, and friction, which is calculated.

The embedded road sensor is flush-mounted in the road. The following variables are recorded: road surface temperature, water film height up to 4 mm, freezing temperature for different de-icing materials such as sodium chloride, magnesium chloride, and calcium chloride, and road conditions such as dry, damp, wet, ice, snow, damp with salt or wet with salt, friction or grip, and ice percentage. The sensor that is shown can also measure underground temperatures when outfitted with additional probes.

The Non-Invasive sensor uses a passive method of analyzing the pavement data. As a result, the data is not as extensive as that from the embedded sensor.

The embedded road sensor provides a greater breadth of data. However, as shown in the picture, to install and maintain the sensors, the roadway needs to be closed to traffic. In order to maintain the non-invasive sensor, a bucket truck will be required; however, no lane closure is needed if there is enough room for the bucket truck to park.

Sensor – Visibility

Modern visibility sensors use forward light scattering technology to measure visibility. This technology can be used for up to 12 miles.

The current FDOT Developmental Specification 688 requires ±10% from 0.005 to 1 mile.

Sensor – Wind Direction and Speed

Per the Developmental Specifications, ultrasonic anemometers and other environmental sensors shall not rely on moving parts, unless otherwise shown in the plans. The legacy sensors that used moving parts were subject to greater maintenance efforts.

For wind sensors, the directional requirement is ±3° between 0 and 360° and the speed requirement is ± 3% between 0 and 120 mph.

You may see legacy mechanical velocity anemometers such as the *vane anemometer* deployed in Florida. It may be described as a windmill or a propeller anemometer. They are being replaced with ultrasonic anemometers. An example of a mechanical anemometer is shown in the picture.

Camera Collocated with RWIS

Often, a camera is mounted on the RWIS structure. The camera is used to verify the weather conditions reported by the RWIS. To minimize network traffic, images are usually polled at a low frequency, perhaps every 5 or 10 minutes, although the cameras have the ability to update images at much higher frequencies. This picture shows a fixed camera collocated with a non-intrusive pavement sensor. This pairing is useful in ensuring accurate readings and reporting; the camera will be able to verify the icy road conditions detected by the pavement sensor.

Conclusion

This concludes the Intelligent Transportation Systems Construction Engineering and Inspection Training, for Road Weather Information System, Module 1 Overview.

Please continue to the next lesson, Module 2 Phases, Documents, and Inspection.

Knowledge Check

1. What does RWIS stand for? Choose the item below that properly describes the ITS acronym from the current training.
   a. Raw Water Intake Structure
   b. Road Weather Information System
   c. Restraint Wheel Induction System
   d. Radio Wait-time Information Stack

2. Determine whether the following statement is TRUE or FALSE. “The RWIS provides weather-related information to Regional Transportation Management Centers (RTMC).”
   a. true b. false

3. Determine whether the following statement is TRUE or FALSE. “The RWIS is used to carry out testing of various pavement treatments designed to ensure safe connected vehicle (CV) travel.
   a. true **b. false**

4. The Innovative Products List is best described as a list that:
   a. contains the names and parts numbers of items that have become obsolete and have been taken off the Approved Product List.
   b. outlines all approved alternatives to tested and widely-used ITS equipment and parts.
   c. provides all expiration and “best used by” dates for all ITS equipment and parts related to RWIS.
   d. identifies products under consideration by the FDOT in conjunction with corresponding Developmental Specifications.

5. Which of the following pairs are NOT sensor components of an RWIS unit?
   a. ambient air temperature and pavement temperature sensors
   b. barometric pressure and precipitation sensors
   c. fiber optic pore water pressure and gyro (angular velocity) sensors
   d. visibility and wind sensors

6. Determine whether the following statement is TRUE or FALSE. "Compared to non-invasive types, embedded pavement temperature sensors offer a limited range of data collection but much lower maintenance costs.”
   a. true **b. false**

7. What does NTCIP stand for? Choose the item below that properly describes the ITS acronym from the current training.
   a. National Transportation Communications for ITS Protocol
   b. National Trade Corridor Improvement Program
   c. Negative Temperature Coefficient Information Processing
   d. National Training Center for ITS Planning