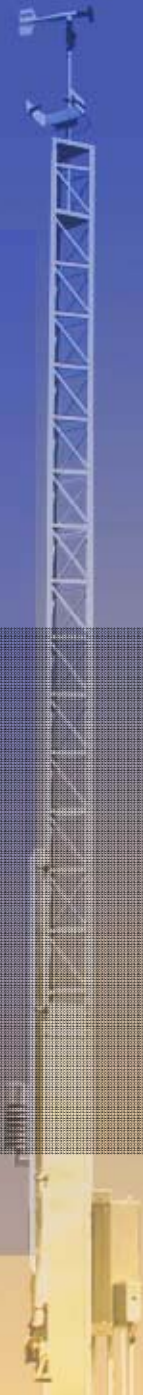


Training for Field Test Procedures for Environmental Sensor Stations

National Cooperative Highway
Research Program
Project 6-15



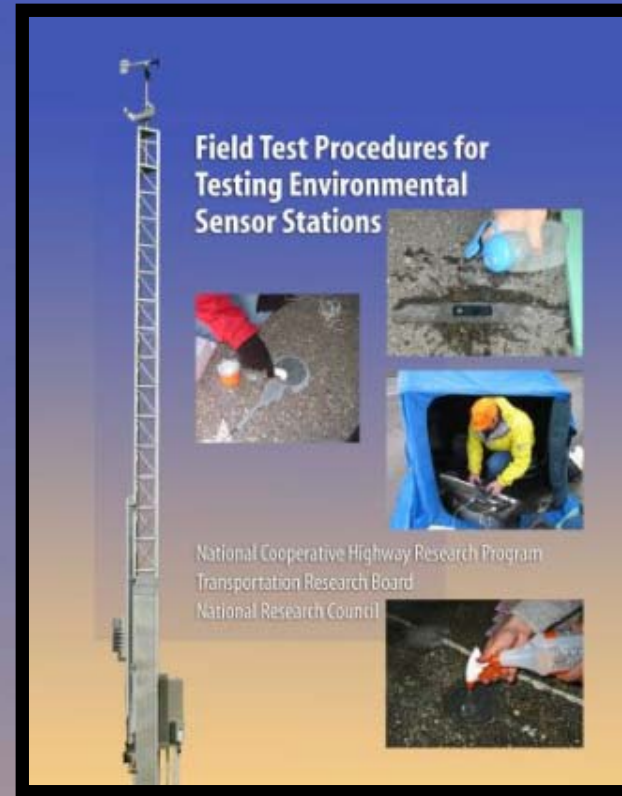
Presentation Outline

- Project Overview
- Definitions
- Safety
- Equipment
- Test Procedures
- Schedule



Project Overview

- Sponsored by National Cooperative Highway Research Program (NCHRP)
- Developed methods for testing pavement sensors at environmental sensor stations



Test Overview

- Complete set of procedures may be run over a few hours
- Procedures identify faulty/miscalibrated sensors
- Procedures are not meant for calibrating sensors



Test Overview (cont.)

- Important to understand how sensor operates within overall RWIS system
 - For example, does RPU consider both pavement sensor and air sensor when providing readings?
- Read all owner's manuals thoroughly



Definitions

- **ESS**
 - Environmental Sensor Station
- **RPU**
 - Remote Processing Unit
- **RWIS**
 - Road Weather Information System



Safety

- Good weather conditions are essential
- Lane closure necessary to directly access the pavement sensor
- Assistance from a second operator if circumstances allow
- Shelter tent protects both operator and sensor



Equipment Overview

- Equipment required for test setup
 - Equipment required for all tests
 - Chemical solution preparation
- Equipment required for each test is presented with its respective test section*



Equipment Required for Test Setup



Portable computer



Communication cables



**Extension cords
(200 feet or longer
as needed)**



Equipment Required for All Tests

APPENDIX C
Testing and Maintenance Forms for Parameter Sensors

State of operation: _____ Date: _____
Agency: _____
Location of BUI: _____
Location of Parameter Sensor (if multiple sensors): _____
Sensor Identification: _____ Serial Serial Number: _____

Initial Parameter Sensor Readings:

Parameter Sensor Temperature: _____ Air Temperature: _____
Parameter Sensor Battery Type: _____ Date Date: _____
Parameter Sensor Reading Date: _____

Water Conditions: _____
Observation of Parameter Sensor on Arrival: _____

Action Recommendations to be completed after testing: _____

EPA 823-B-11-001
EPA Test Methods for Environmental Water Testing

Copies of the Testing and Maintenance Forms (Appendix C)



Knee pad



Paper Towels



Calculator



Watch for keeping time

Chemical Solution Preparation

Instructions on chemical preparation are included in Appendix B of Field Testing Procedures for Environmental Sensor Stations

- Sodium chloride
- Magnesium chloride
- Calcium chloride



Field Tests: Field Test Plan

- **Field Test 1: Pavement Temperature at Ambient Conditions**
- **Field Test 2: Pavement Surface Dry/Wet/Ice Conditions**
- **Field Test 3: Freezing Point of Passive and Active Pavement Sensors**
 - 3A: Testing Freezing Point Using Passive Sensors
 - 3B: Testing Freezing Point Using Active Sensors
- **Field Test 4: Ice Bath at 32° F (Optional)**



Field Test 1: Pavement Temperature at Ambient Conditions

- Objective
 - Test accuracy at ambient pavement temperature



Field Test 1: Equipment



Two handheld thermometers with precision thermistors



Brick with insulation on bottom surface to secure thermistor to pavement sensor



Thermal conductive paste



Supply of tap water to clean pavement



Nylon brush to clean the pins on top of the sensor



Shelter tent, such as a collapsible ice fishing shelter



Paint can opener



Field Test 1:

Pavement Temperature at Ambient Conditions

- Procedure
 - Shield sensor from sun/wind
 - Clean test area
 - Affix thermistors to pavement with thermal paste and cover with insulated brick
 - 2 1/2" from sensor
 - On sensor
 - Record temperature data every two minutes until temperature stabilizes
 - Clean test area when finished

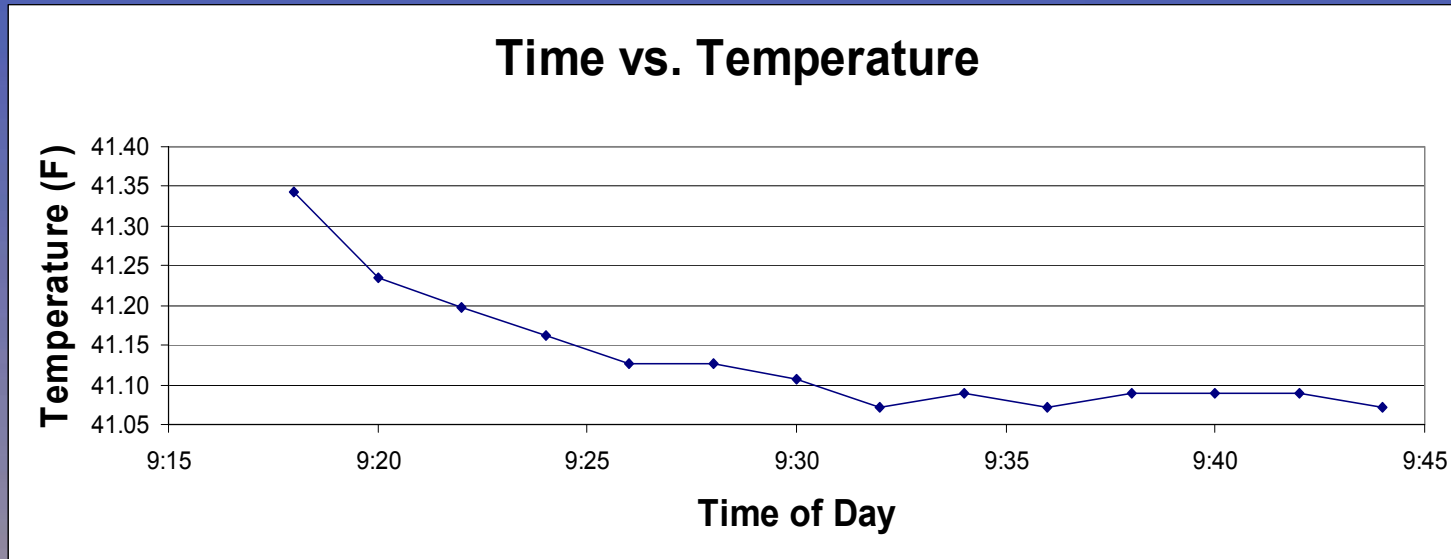


Stability criteria:

Four consecutive temperature readings are within 0.4° F (0.2° C) of each other

See next slide for an example

Field Test 1: Example of Temperature Stabilization



Example of temperature stabilization

Field Test 1: Lessons Learned

- Best results when test is begun close to sunrise
 - If test is started much after daybreak, sensors often require an hour to stabilize
 - Sensor and thermistors must be shaded from solar radiation for at least 15 minutes prior to and during test
- Thermistors and thermometers should be calibrated annually
- Sensor surface must remain dry and clean throughout the test
- The thermal paste becomes stiff if subjected to cold temperatures
 - Keep the thermal paste warm until it is needed
- Thermistors require time to stabilize after being handled; avoid contact with skin



Field Test 2:

Pavement Surface Dry/Wet/Ice Conditions

- Objective
 - Determine whether sensor can detect dry/wet/ice conditions



Field Test 2: Equipment



Heat gun



Misting bottle filled with tap water



Nylon brush to clean the pins on top of the sensor



0.5 mm feeler gauge to measure film depth



Thermometer and thermistor to check air/pavement temperature



Optional: Shelter tent, such as collapsible ice fishing shelter



Field Test 2:

Pavement Surface Dry/Wet/Ice Conditions

Procedure

Dry

- Clean and dry pavement sensor
- Compare RPU reading with sensor surface
- Collect and record two readings



Wet

- Spray pavement sensor with tap water and check film depth
- Compare RPU reading with sensor surface
- Collect and record two readings



Ice

- Wait for water to freeze
- Compare RPU reading with sensor surface
- Collect and record two readings



Field Test 2: Lessons Learned

- Weather must be dry or the pavement sensor must be sheltered from precipitation
 - Dry and wet surface state can be evaluated at any temperature
 - To form ice, the pavement temperature must be below 32° F
- Before a freezing temperature is reached on the sensor it should give a “wet” reading
- If required by the RPU, atmospheric sensors must be connected and working properly
 - Be sure to understand the relationship between all sensors and how each may impact test results



Field Test 3A: Testing Freezing Point Using Passive Sensors

- Objective
 - Determine accuracy of passive sensor freezing point
- Sensor detects salinity/freezing point



Field Test 3A: Equipment



Device to shelter sensor from evaporation due to wind and sun (ice fishing shelter or 5-gallon bucket)



One gallon of distilled water



Heat gun



0.5 mm feeler gauge to measure film depth



Misting bottle filled with 4% chemical solution



Field Test 3A:

Testing Freezing Point Using Passive Sensors

- Procedure
 - Clean pavement sensor with towels
 - Spray pavement sensor with 4% brine and check film depth with feeler gauge
 - Monitor freezing point stability by recording data points every 2 minutes
 - Record freezing point data every 2 minutes until temperature stabilizes
 - Repeat process with 15% brine



Stability criteria: Four consecutive temperature readings that are within 3.6° F (2.0° C) of each other

Field Test 3A: Lessons Learned

- Use the same type of chemical used in maintenance operations
- Ambient pavement temperature must be within the sensor's range for measuring freezing point
 - See Appendix B for brine properties and check with the manufacturer's documentation for temperature compliance
- Passive sensors are very sensitive to concentration changes and film thickness
- It is important to thoroughly clean the pavement sensor between runs with distilled water



Field Test 3B:

Testing Freezing Point Using Active Sensors

- Objective
 - Determine accuracy of active sensor freezing point
- Sensor detects salinity/freezing point by heating and cooling the sensor



Field Test 3B: Equipment



**One gallon of
distilled water**



**Device to shelter sensor from
evaporation due to wind and
sun (ice fishing shelter or
5-gallon bucket)**



**0.5 mm feeler
gauge to
measure
film depth**



**Nylon brush to
clean the pins on
top of the sensor**



**Two misting bottles filled
with 4% and 15% chemical
solution**



Field Test 3B:

Testing Freezing Point Using Active Sensors

- Procedure
 - Clean pavement sensor
 - Spray pavement sensor with 4% brine
 - Check film depth with feeler gauge
 - Record freezing point readings
 - Repeat process with 15% brine



Stability criteria:

Four consecutive temperature readings that are within 3.0° F (1.7° C) of each other

Field Test 3B: Lessons Learned

- Use the same type of chemical used in maintenance operations
- Test procedures recommend the use of 4% and 15% salt solutions
 - Information about preparing other concentrations of solution is provided in Appendix B
- Flush the pavement sensor with distilled water
 - Removes salt/impurities
- Some active sensors require data from passive sensors
 - Perform the procedures on all applicable sensors
- Be sure to wait proper length of time for active sensor to complete a full cycle – see owner's manual



Field Test 4:

Ice Bath at 32° F

- Objectives
 - Force the pavement sensor to 32° F
 - Measure difference between known temperature and pavement sensor reading



Equipment Required for Test 4: Ice Bath at 32° F



**Thermal conducting
paste**



**One handheld
thermometer with
precision thermistors**



**One gallon of
chilled distilled
water**



**Stirring instrument
such as a plastic
slotted spoon**



**10-inch section of 12-
inch diameter PVC pipe**



**10 pounds of
crushed ice cubes**



Plastic bag



Field Test 4: Ice Bath at 32° F

- Procedure
 - Clean test area
 - Place PVC section around sensor
 - Put plastic bag in PVC section
 - Fill with distilled water
 - Add crushed ice and stir constantly
 - Record data every 2 minutes until temperature stabilizes



Field Test 4: Lessons Learned

- Test is only effective on sensors with temperature sensing elements located near the surface of the sensor
 - Test takes too long if the element is buried
 - Check with the sensor vendor for more information
- The ambient temperature of the pavement should be between 32° F and 50° F
 - The test will take more time if performed at warmer temperatures
- Ice may be crushed before going out to the ESS site or at the site
 - Ice will cool the bath faster if it is crushed into small pieces



Possible Testing Schedule

Time	Task	Description
8:00 - 8:30	Setup (30 min)	
8:30 - 9:00	Field Test 1 (30 min)	Ambient Temp
9:00 - 9:30	Field Test 2 (30 min)	Surface State
9:30 - 10:00	Field Test 3 (30 min)	Freezing Point
10:00 - 10:45	Field Test 4 (Optional, 45 min)	Ice Bath

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