TEST PLAN FOR

COMPARISON OF FREEZING RAIN SENSORS
TWO-PIECE PROBE VS ONE-PIECE PROBE
NOVEMBER 2004 – APRIL 2005

Version 3
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Prepared for

ASOS Product Improvement Program

National Weather Service W/OST32

by

Science Applications International Corporation
An Employee-Owned Company

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1.0 BACKGROUND

The Automated Surface Observing System (ASOS) uses the Rosemount Model 872C3 Freezing Rain Sensor to detect ice accretion. Supercooled water droplets impact a vibrating sensor probe and freeze to its surface. The result is a decrease in resonant frequency of the probe. The sensor undergoes a deicing cycle to melt the accumulated ice when specific criteria are met.

Recently, Goodrich bought out Rosemount and began to produce a freezing rain sensor manufactured by the Goodrich Sensor Systems division. The new freezing rain sensor has a one-piece probe instead of the two-piece probe that is currently on fielded ASOS systems.

2.0 PURPOSE

The purpose of this test is to verify that the new one-piece probe design performs at least as well as the old two-piece probe design.

3.0 TEST APPROACH

3.1 Sensor Description

The Rosemount Model 872C3 (Figures 1 & 2) and the Goodrich Freezing Rain Sensor will be used in this test. These sensors detect ice accumulation from any source (freezing rain, freezing drizzle, rime from fog, and hoarfrost) by monitoring the resonant frequency (nominally 40,000 hertz) of a vibrating probe. The Rosemount design is a two-piece probe, while the Goodrich design is a one-piece probe. The resonant frequency decreases with increasing ice accretion. Data are acquired from the sensor once each minute.

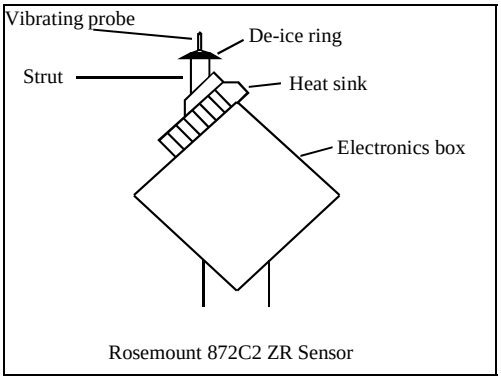


Figure 1 Freezing Rain Sensor

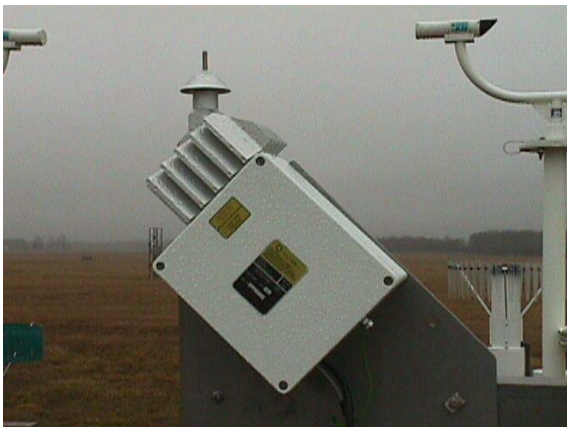


Figure 2 Freezing Rain Sensor (actual)

3.2 Test Location and Sensor Configuration

The test will be conducted at the ASOS test site in Johnstown, Pennsylvania (see Appendix A for a map of the testbed). Testing will occur from November 15, 2004 to April 15, 2005. The freezing rain configuration at the test site will be as follows:

Serial No.	Sensor	Type
1177	Goodrich Freezing Rain	One-piece
1250	Goodrich Freezing Rain	One-piece
370	Rosemount Freezing Rain	Two-piece
927	Rosemount Freezing Rain	Two-piece

Table 1 Freezing Rain Configuration

3.3 Data Collection

One minute data will be collected from all test and reference weather sensors using a personal computer based data acquisition system (DAS).

3.4 Weather Observations

Detailed surface observations will be made by SAIC and NOAA/NWS observers at the test sites during covered events. Observers will be deployed to cover events when a significant period of precipitation is forecast. For this test, event coverage decisions will be made based on forecasts of freezing rain and/or ice pellets exceeding two hours.

During events, the observers will:

- record precipitation onset/cessation times
- record type and intensity of precipitation, with a resolution of five minutes
- inspect the test sensors at least once per hour during events and take photographs of unusual occurrences (e.g., snow/ice accretion around the probe)

4.0 TEST METHODOLOGY AND ANALYSIS

Analysis will be conducted on all covered freezing precipitation events that occur at Johnstown, Pennsylvania. All results will be reported in tabular and/or graphical form. The reference for this test will be the human observer. All sensors will be compared to the SAIC and NOAA/NWS observer.

4.1 Metrics

4.1.1 Frequency drift

All sensors will be calibrated and baseline frequencies will be established prior to the test. The baseline frequency prior to the test will be compared to the baseline frequency at the end of the test. Any drift from the initial baseline frequency will be noted for each sensor. In addition to a comparison over the entire test period, monthly checks will be made during benign atmospheric conditions in order to track changes in idle frequencies. The goal of this metric is to have a drift of zero.

4.1.2 Sensor frequency difference

This metric will show the minute-by-minute frequency difference between each and all of the sensors for each event. Results will be displayed in binned graphs.

Sensor frequency difference = one-piece – one-piece
Sensor frequency difference = one-piece – two-piece
Sensor frequency difference = two-piece – two-piece

4.1.3 Reportable precipitation types

The number of minutes from each sensor in each precipitation category will be compared to the output from the human observer. Precipitation categories will not include intensities since intensities are based on the LEDWI output and not dependent on the freezing rain sensor. The results will be displayed in a table similar to the following:

Number of coincident minutes (human vs. sensor) for each precipitation type				
Precipitation Types	***One-Piece (New)***		***Two-piece (Old)***	
	1177	***1250***	***370***	***927***
FZRA				
FZDZ				

Table 2 Coincident Precipitation Types

4.1.4 De-icing categories

The number and type of de-ices from each sensor will be displayed in a table similar to the following:

Number of de-ices for each category				
De-icing Categories	***One-Piece (New)***		***Two-Piece (Old)***	
	1177	***1250***	***370***	***927***
Accretion				
Clamping				
End-Of-Event				

Table 3 De-icing categories
Accretion: ≤ 39,473 hertz (0.08 inches)
Clamping: ≥ 40,021 hertz
End-Of-Event: Frequency change < 13 hertz (0.002 inches) in 15 minutes

5.0 DATA REPORTING AND TEST SCHEDULE

A final report will be submitted no later than May 13, 2005.

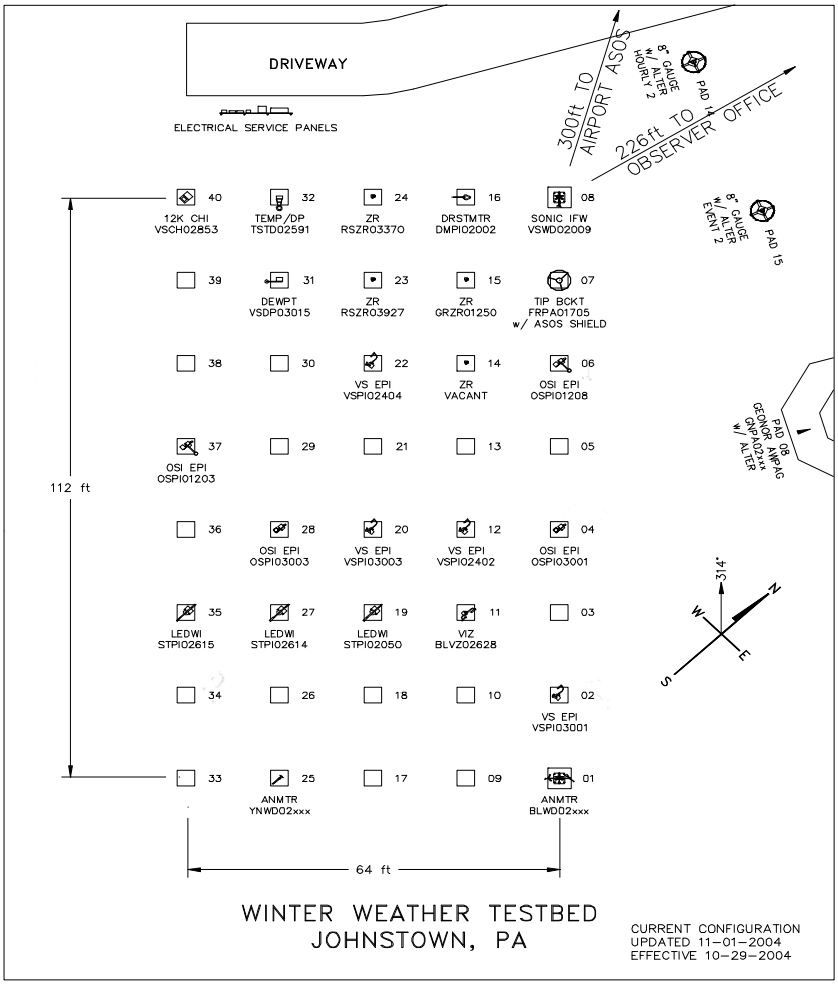
Table 4 below contains the schedule for the start/end of the test and any deliverables.

EVENT	***START DATE***	***COMPLETION DATE***
Test Start Date	November 15, 2004	April 15, 2005
Draft Final Report	April 29, 2005	May 13, 2005
Final Report	Upon receipt of comments	10 days after receipt of comments
Final briefing	Upon Government acceptance of Final report	Two weeks after Government acceptance of Final Report

Table 4 Test Schedule

6.0 RESPONSIBILITIES

Test Director	M. D. Gifford, NWS
Program Manager	J. Fiore, SAIC
Lead Meteorologist	J. Dover, SAIC
Data Acquisition System Software	M. Childs, SAIC
Technicians	D. Eckberg, SAIC D. Propst. SAIC

Table 5 Responsibilities

APPENDIX A: Johnstown, Pennsylvania Test Site