SAE Aerospace
An SAE International Group

AEROSPACE RECOMMENDED PRACTICE

SAE ARP5623

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Mobile Digital Infrared Pavement Surface, Ambient Air and Dew Point Temperature Sensor System

RATIONALE

This SAE Aerospace Recommend Practice is intended to provide airport operators a basic understanding and set of requirements for a vehicle mounted electronic system to provide the end user with real-time readings of surface, air, and dew point temperatures of airfield pavement areas including runways, taxiways, ramps, bridges, vehicular roadways, parking garages, and parking lots.

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1. SCOPE

This SAE Aerospace Recommended Practice (ARP) covers the requirements for a combined Mobile Digital Infrared Pavement Surface, Ambient Air, and Dew Point Temperature Sensing System (referred to as the system). The system monitors real-time surface, air and dew point temperatures of airfield pavement areas to ensure safe winter ground operations of aircraft and other vehicles. The vehicle mounted electronic system provides the operator with real-time readings of surface, air and dew point temperatures of airfield pavement areas including runways, taxiways, ramps, bridges, vehicular roadways, parking garages and parking lots. The electronic system shall be available with or without the dew point sensing option.

This electronic system can be utilized as a stand alone system at small airports, or may be used to augment airport operations that currently have a Stationary Runway Weather Information System (reference ARP5533). Because the electronic system is mobile, it can be utilized to measure pavement temperatures at locations where an in-pavement sensor or weather station is not located.

2. APPLICABLE DOCUMENTS

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

ARP5533 Stationary Runway Weather Information Systems (In-Pavement)

2.2 FAA Publications

Available from Federal Aviation Administration, 800 Independence Avenue, SW, Washington, DC 20591, Tel: 866-835-5322, www.faa.gov.

Latest Edition - AC 150/5200-30C: “Airport Winter Safety and Operations”

3. TECHNICAL REQUIREMENTS

3.1 General Description

The full electronic system shall consist of the following components (not all components are required for a basic system) (see Figure 1).

3.2 Temperature Sensors

The electronic system shall include a mobile infrared pavement surface temperature sensor, an ambient air temperature sensor, and (an optional) dew point temperature sensor. The sensors are typically mounted on airfield operations or maintenance vehicles (such as patrol vehicles, anti-icing trucks, friction testers, plows, multifunction vehicles, etc.). These types of vehicles drive on airfield pavements where the system data is extremely useful in making important winter maintenance and operations decisions. These decisions include determining the type and application of anti-icing chemicals, and the correct snow removal techniques to utilize to maintain acceptable pavement surface friction readings. The optional dew point sensor enables the operator to predict when atmospheric and pavement conditions are favorable for formation of frost or black ice on the surface of the pavement.

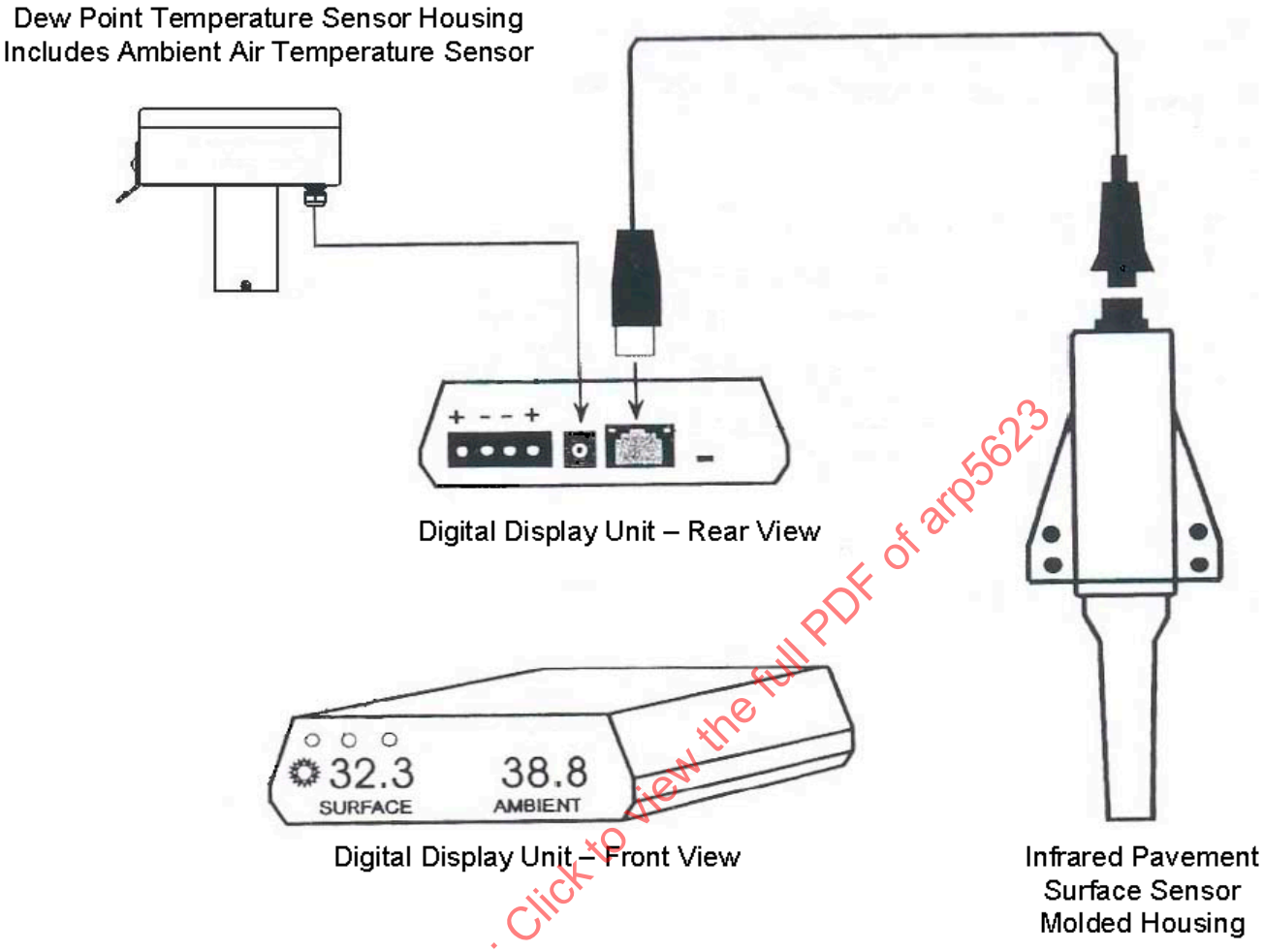

FIGURE 1 - SYSTEM COMPONENTS

3.3 Digital Display Unit

The digital display unit is required to display real-time measured temperature parameters to the operator on a high intensity LED screen, (see 4.10.2). The digital display is also used by the operator of the vehicle to control the system features, and to calibrate the system for accuracy. The digital display unit is mounted in the cab of the vehicle in direct sight of the driver.

4. VEHICLE MOUNTED SENSORS

4.1 Performance

The mobile infrared pavement surface temperature sensor shall sense and electronically transmit pavement surface temperature to the digital display unit for dissemination of the real-time data to the vehicle operator. Additionally, the ambient air temperature sensor shall sense and electronically transmit air temperature to the digital display unit. Optionally, a dew point sensor shall sense and electronically transmit dew point temperature to the digital display unit.

4.2 Design

Sensors shall be solid state in design without relays, tubes or other electromechanical devices. The infrared pavement sensor shall have the capability to be field calibrated by the user to maintain accuracy. The ambient air temperature and dew point temperature sensors shall be factory calibrated and no adjustment or calibration shall be required by airport users. The system shall be supplied with removable/repairable components and sensors for ease of troubleshooting and repair to extend the life of the electronic system. The system design should not be an all-in one design and shall not be considered throw away technology (i.e., when a malfunction occurs, the system is discarded and replaced with an entire new system instead of repairing system components).

4.3 Radio Frequency Hardening

The entire system including the three sensors, digital display and interconnection cables shall be manufactured with shielding and filter circuitry to be resistant to radio frequency interference. This type of design is known as “radio frequency hardening”. Radio signals are prevalent on an all airfields, and operations patrol vehicles can contain multiple radio transmitting sources. Therefore, radio frequency hardening is particularly important to shield the system electronics from radio frequency induced noise and interference which could otherwise degrade the system operation and accuracy.

4.4 Infrared Pavement Temperature Sensor Requirements

The mobile infrared pavement temperature sensor shall be constructed only with an optically polished germanium crystal lens which the pavement infrared radiation is measured through. This type of lens greatly increases system accuracy by passing the infrared signal through with no attenuation, and it also filters out unwanted wavelengths of light. Lenses fabricated of glass or plastic will not pass infrared without attenuating the signal and negatively impacting the pavement temperature reading accuracy, making them unsuitable as a material for lens construction.

The mobile infrared pavement temperature sensor shall be constructed with a tapered, injection molded cone, protective housing. The housing shields the sensor lens from contamination by vehicle tire-spray and other contaminants.

CAUTION: Any solid matter contamination which collects on the sensor lens will be measured the same as the pavement surface, thus decreasing measured pavement accuracy significantly. The cone housing shall be removable for the user to periodically clean the lens with a non-abrasive lens cleaner.

The mobile infrared pavement temperature sensor shall have the capability of being installed remotely from the digital display with a cable of up to 100 feet long. This enables the installer to custom mount the sensor on a wide variety of snow removal vehicle types to measure pavement temperature with the greatest accuracy to overcome contaminant problems with the lens. It also provides flexibility to mount the sensor at a wide variety of locations on the vehicle under-body.

4.5 Infrared Sensor Specifications

The purpose of this system is to measure and detect in real-time the presence of an imminent freezing pavement condition. Therefore, the accuracy and repeatability of the infrared sensor portion of the system is extremely important. The infrared probe shall be designed to contain a temperature compensation circuit to increase the surface temperature reading accuracy in all types of climates.

For example, without such compensation, a host vehicle driven out of a warm garage into colder temperatures could take up to an hour to stabilize for accurate readings.

The mobile infrared pavement surface sensor shall have sufficient durability to function over a range of air temperatures from -40 to 160 °F (-40 to 71.1 °C). Accuracy of the sensor shall be ±0.5 °F (±0.28 °C) at 32 °F (0 °C) in operating ambient from 0 to 120 °F (17.8 to 48.9 °C). Accuracy of the sensor out of the normal stated range shall be ±3.0 °F (±1.0 °C). The system shall have an operating relative humidity range of 0 to 100%.

The infrared sensor shall be capable of attaining a measured repeatability of ±0.1% of full scale.

Field calibration shall have an adjustable range of ±5.0 °F (±2.8 °C) at 32 °F (0 °C).

4.6 Ambient Air Temperature Sensor Requirements

The ambient air temperature sensor shall have the capability of being installed on the host vehicle, remotely from the digital display, with a cable of up to 100 feet long. This allows for mounting of air temperature sensor at locations such as the vehicle front grill, away from heat sources on the vehicle, such as engine heat, exhaust and direct sunlight. This enables the installer to custom mount the sensor on a wide variety of vehicle types to measure air temperature with the greatest accuracy.

CAUTION: The air temperature sensor must always be mounted where good airflow occurs when the vehicle is in motion. It must never be mounted in a location where direct sunlight can shine on it.

4.7 Ambient Air Temperature Sensor Specifications

The ambient air temperature sensor shall have sufficient durability to function over a range of air temperatures from -40 to 160 °F (-40 to 71.1 °C). Accuracy of the air temperature sensor shall be ±0.5 °F (±28 °C) at 32 °F (0 °C) in operating ambient from 0 to 120 °F (17.8 to 48.9 °C). Accuracy of the sensor out of the normal stated range shall be ±3.0 °F (±1.0 °C). The system shall have an operating relative humidity range of 0 to 100%.

4.8 Dew Point Temperature Sensor Requirements (Optional)

When the system includes the optional dew point sensor, both the dew point sensor and the air temperature sensor are mounted inside a white reflective plastic housing. The housing has an air intake to provide air flow to the both sensors, and shields them from sunlight and other sources of heat, while the vehicle is in motion. The housing should be mounted to face forward so the air intake points in the direction of vehicle travel.

The dew point sensor shall have the capability of being installed on the host vehicle, remotely from the digital display, with a cable of up to 100 feet long. This enables the installer to custom mount the housing on a wide variety of vehicle types to measure dew point and air temperature with the greatest accuracy. The dew point housing must always be mounted where good airflow occurs when the vehicle is in motion. Suggested mounting locations include the vehicle hood, plow mirror, or on top of the truck cab housing.

The dew point sensor shall be supplied factory calibrated and shall not require any calibration or setup to take accurate readings. The housing air intake must always be kept clear of snow/ice or other debris which could cause the unit to react too slowly to take accurate readings. The dew point housing includes a replaceable filter, which should be checked once a year and replaced if dirty. Exposure to extreme amounts of chemicals or dust could cause the filter to clog and the unit performance to degrade until replaced.

4.9 Dew Point Temperature Sensor Specifications

The dew point sensor shall have sufficient durability to function over a range of air temperatures from -40 to 160 °F (-40 to +71.1 °C). Accuracy of the dew point sensor shall be ±3.0 °F (±1.0 °C) at 32 °F (0 °C) at relative humidity values of greater than 70%. Accuracy of the sensor out of the normal stated range shall be ±3.0 °F (±1.0 °C). The system shall have an operating relative humidity range of 0 to 100%.

4.10 Digital Display Unit

4.10.1 Performance

The system shall be supplied with an integrated high intensity LED display to allow the driver of the host vehicle to view the system data, turn on/off alarms, control and calibrate the system via menu access. The display shall be mounted in the cab of the vehicle in direct sight of the operator.

4.10.2 Design

The digital display housing shall contain a high intensity LED read-out for display of real-time system information. The LED read-out shall be easily discernable by the operator even in direct sunlight. The display shall include an auto-dim feature to automatically lower the brightness in low light or darkness conditions to reduce glare to the operator.

The digital display unit shall be mounted in the cab of the vehicle in direct sight of the operator. An optional display bracket shall also be available for permanent mounting of the display housing.

The display shall consist of two three-digit registers to the display infrared pavement surface temperature and the ambient air temperature separately, side by side. If the optional dew point sensor is provided, the surface and air temperatures shall be displayed alternately with relative humidity and dew point temperature. The software menu system shall allow the operator to turn off the alternating display and choose which parameters to display (either pavement surface and air, or relative humidity and dew point).

The software menu system contained in the display electronics shall be selectable to display either English or Metric units.

The menu system shall also have options to enable the system operator to:

- Turn on/off flashing LED temperature alarm
    - For example - if the temperature dropped below a pre-defined threshold)
- Turn on/off audible temperature alarm
- Perform infrared sensor calibration
- Adjust LED brightness intensity settings
- Switch between display modes
    - Pavement surface temperature or ambient air temperature)

The digital display unit shall operate from a 12 VDC or 24 VDC unregulated power input voltage, which is commonly available on all airport operations vehicles which the system may be installed on. The digital display unit shall provide power to all connected sensors for proper operation.

The system digital display unit can optionally be provided with an RS-232 serial port for connection to a laptop computer. Optional data logging software for a laptop shall also be available for later addition to the system. This optional software shall be capable of downloading and logging all readings from the system onto a laptop, and capable of recording and storing continuous GPS thermal mapping data of the pavement surface.

The system digital display unit shall be capable of optional electronics to provide the following output formats for interfacing to other controls and other devices (not specified in this document):

- RS-232 digital output
- 1-5 volt dc analog output
- 4-20 ma analog output