Designation: E3208 – 20

Standard Specification for Minimum Equipment Requirements for Mobile Surface Contaminant Classification and Measurement Equipment[1]

This standard is issued under the fixed designation E3208; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This standard describes the minimum performance and operating requirements of mobile non-contact surface contaminant monitoring equipment for paved surfaces providing real-time information. The standard deals with measurement equipment detecting and measuring water-based, weather-produced contaminants such as snow, slush, ice, and standing water on paved surfaces.

1.2 This specification is intended as a minimum performance standard that will be referenced by regulatory organizations and industry participants when determining required compliance to minimum performance requirements when the intended function of the equipment is to supply measurements to be used in determination of safety-critical surface condition assessments. These assessments could include information such as that provided for airport runway condition assessments in the FAA TALPA-ARC framework or in the ICAO Global Reporting Format regulations.

1.3 Mobile non-contact surface contaminant measuring devices are vehicle-mounted measurement equipment that measure and classify the type of weather-produced, water-based contaminant on paved surfaces such as water, frost, slush, snow, and ice. The devices can also detect if the paved surface is free of any of these contaminants. The devices are also able to measure the water-equivalent depth of these contaminants on the surface, which is not the physical depth specified in the ICAO and other regulations used in the aviation industry.

1.4 *Units*—The values stated in SI units are to be regarded as standard. The values given in parentheses are mathematical conversions to inch-pound units that are provided for information only and are not considered standard.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.6 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods

2.2 *Other Referenced Documents:*

FAA AC 150/5200-30D Airport Field Condition Assessments and Winter Operations Safety[3]

ICAO Circular 355, AN/211 Assessment, Measurement and Reporting of Runway Surface Conditions[4]

SAE ARP 5623 Mobile Digital Infrared Pavement Surface, Ambient Air and Dew Point Temperature Sensor System[5]

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *classification precision*—the percentage of measurements at which a sensor can correctly classify a contaminant into the defined categories (for example, dry, snow, water, ice, slush, etc.) versus all measurements where the sensor identified contaminants into the defined categories (correctly (True Positive: TP) or falsely (False Positive: FP)). Precision is calculated according to the formula:

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from Federal Aviation Administration (FAA), 800 Independence Ave., SW, Washington, DC 20591, http://www.faa.gov/documentLibrary/media/Advisory_Circular/150-5200-30D.pdf.

[4] Available from International Civil Aviation Organization (ICAO), https://store.icao.int/355.html.

[5] Available from SAE International (SAE), 400 Commonwealth Dr., Warrendale, PA 15096, http://www.sae.org/standards/content/arp5623.

$$\text{Pr(contaminant type)} = \frac{\text{TP(contaminant type)}}{\text{TP(contaminant type)} + \text{FP(contaminant type)}} \quad (1)$$

$$\text{PR} = \frac{\Sigma_{\text{contaminant}}\text{Pr(contaminant)}}{\text{Number of contaminant types}}$$

where:

TP(contaminant type) = number of surfaces with correctly classified contaminant for the specified contaminant type, and

FP(contaminant type) = number of surfaces that were incorrectly classified as the specified contaminant type.

For example, in a study where a sensor is tested on four contaminants (dry, ice, water, snow) with ten measurements on each of the three surfaces with the following results:

Sensor	True Contaminant				
Classification	Dry	Water	Snow	Ice	
Dry	9	0	0	0	TP = 9, FP = 0
Water	0	9	1	1	TP = 9, FP = 2
Snow	0	0	7	0	TP = 7, FP = 0
Ice	1	1	2	9	TP = 9, FP = 4
	FN = 1	FN = 1	FN = 3	FN = 1	

TP(Dry) = 9 and FP(Dry) = 0 would mean that the specific sensor identified dry surface nine times correctly and no other contaminated surface was identified as "Dry"; also TP (Water) = 9 and FP(Water) = 2 would mean that the specific sensor identified water nine times correctly and two other surfaces were incorrectly identified as water; and similarly TP(Snow) = 7 and FP(Snow) = 0 means that the sensor classified snow seven times correctly and no other surfaces were identified incorrectly as snow. (TP(Ice) = 9, FP(Ice) = 4) the precision is PR = 0.878 or 87 %.

3.1.1.1 *Discussion*—Precision is a direct measure of a sensor's ability to prevent Type I errors or false positives that classify, for instance, a snow surface as wet, or an ice surface as snow, etc. (the predicted condition is more "positive" than the actual condition).

3.1.2 *classification recall*—the percentage of measurements at which a sensor can correctly classify a contaminant into the defined categories (for example, dry, snow, water, ice, slush, etc.) versus the true number of actual surfaces falling into the category. Recall is calculated according to the formula:

$$\text{Re(contaminant type)} = \frac{\text{TP(contaminant type)}}{\text{TP(contaminant type)} + \text{FN(contaminant type)}} \quad (2)$$

$$\text{RE} = \frac{\Sigma_{\text{contaminant}}\text{Re(contaminant)}}{\text{Number of contaminant types}}$$

where:

TP(contaminant type) = number of surfaces with correctly classified contaminant for the specified contaminant type, and

FN(contaminant type) = number of times the true contaminant was incorrectly classified.

For the same data given in the example in 3.1.1, the recall is RE = 0.850 or 85.0 %.

3.1.2.1 *Discussion*—Recall is a direct measure that classifies the sensor's ability to prevent Type II errors or false negatives that classify, for instance, a dry surface as wet or a wet surface as snowy, etc. (the predicted conditions are more "negative" than the actual conditions).

3.1.3 *compacted snow*—snow which has been compressed into a solid mass that resists further compression and will hold together or break up into lumps if picked up; density is 500 kg/m^3 (31.2 lb/ft^3) and over. Compacted snow has been compressed into a solid mass such that the airplane wheels, at representative operating pressures and loadings, will run on the surface without causing significant rutting. Differentiation between compacted snow and ice can be unclear (see 3.1.11); for reporting uncertain contaminant types, refer to 5.3.1.2.

3.1.4 *contaminant*—for purposes of condition reporting on paved surfaces, a defined surface area is considered contaminated when the specified surface area is covered by frost, ice, snow, slush, or water. Under the guidance provided for airport runway condition assessments in the FAA TALPA-ARC and the ICAO Global Reporting Format framework, a surface is considered contaminated if 25 % or more of the surface area is covered by contaminants.

3.1.5 *dry snow*—snow that can be blown if loose, or if compacted, will fall apart again upon release (also called loose snow); density is equal or less than 350 kg/m^3 (21.8 lb/ft^3).

3.1.6 *DSR*—dedicated short-range radio communication; one-way or two-way short-range to medium-range wireless communication channels specifically designed for mobile and automotive use and a corresponding set of protocols and standards.

3.1.7 *frost*—frost consists of ice crystals formed from airborne moisture that condenses on a surface whose temperature is below freezing. Frost differs from ice in that the frost crystals grow independently and, therefore, have a more granular texture.

3.1.8 *GNSS*—global navigation satellite systems other than the U.S. GPS system, such as navigation satellite systems used by Russia, the European Union, or China.

3.1.9 *GPRS*—general packet radio service (GPRS) is a packet-oriented mobile data service on the 2G and 3G cellular communication systems' global system for mobile communications (GSM).

3.1.10 *GPS*—global positioning system.

3.1.11 *ice*—the solid form of frozen water or compacted snow that becomes impermeable with density that exceeds 801 kg/m^3 (50 lb/ft^3). The density of solid frozen bubble-free water is equal to 917 kg/m^3 (57.25 lb/ft^3). By convention, compacted snow that has become impermeable (there are no connected air passages) is called ice. This occurs at a density of about 801 kg/m^3 (50 lb/ft^3).

3.1.12 *physical contaminant depth*—the depth of a specific contaminant as measured by physical means from a perfectly smooth surface to the top of the contaminant. The relationship between the water-equivalent and physical contaminant depths