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Introduction

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Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/ Figure/Table/Note	Type of comment	Comment (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	



DRAFT International Standard

ISO/DIS 8932-2

Meteorology — Radiosonde — Part 2: Laboratory test method for errors in radiosonde humidity sensor calibration

ICS: 07.060

ISO/TC 146/SC 5

Secretariat: **DIN**

Voting begins on:
2025-03-26

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2025-06-18

This document is circulated as received from the committee secretariat.

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Foreword

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This document was prepared by Technical Committee ISO/TC 146, Air quality, Subcommittee SC 5, Meteorology.

A list of all parts in the ISO 8932 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Temperature and water vapour (i.e., humidity) are two of the basic atmospheric variables and are important for the initialization of numerical weather prediction and climate modelling. Radiosondes are widely used to measure atmospheric parameters such as humidity and temperature up to an altitude of approximately 40 km. A radiosonde is a balloon-borne instrument with several types of sensors for in situ profile measurements. A radio transmitter is used to send these data to the observing station.^[1] Radiosonde observations are often used in conjunction with other measurement techniques such as remote sensing using satellites to provide comparative data. For radiosonde-derived data to be useful, the measurement accuracy of the radio soundings needs to be known. From a metrological perspective, this measurement accuracy should be expressed in terms of uncertainty that is traceable to the International System of Units (SI).

Previously, comparative soundings of dew-point hygrometers and radiosondes showed that radiosonde humidity sensors have a daytime dry bias resulting from solar heating and a time-lag error at low temperatures.^[2,3] The dry-bias and time-lag error can be corrected in sounding systems by creating proper algorithms based on measurements of sensor temperature and response time, respectively. In addition, polymeric thin-film humidity sensors adopted by most radiosondes are known to produce systematic errors at the low temperature characteristic of the upper air environment if a calibration curve obtained at room temperature only is employed for low temperatures.^[4,5] The capacitance of humidity sensors increases with adsorbed water vapor in thin films. While the adsorption capacity of the films for water vapor increases at lower temperatures, it does not fully compensate for the reduced water vapor pressure, leading to temperature-dependent behaviour in thin-film humidity sensors. Therefore, calibration of these sensors should be conducted at various temperatures. Thus, an essential prerequisite to resolve above issues and to improve the measurement reliability of radiosondes is to calibrate the radiosonde sensors using ground-based facilities^[6,7].

The relative humidity generated by a laboratory setup or factory facility can be traceable to the SI via temperature, pressure, gas flow rate, and/or mass measurements related to determining water vapor pressure from the humidity generator itself and/or the measurement of the generated humidity using calibrated precision hygrometers. The SI traceability of radiosonde humidity sensors should be established through factory calibration by manufacturers. This document is mainly focused on testing the calibration error of humidity sensors in radiosondes, which are randomly sampled from a series of products.

The Standing Committee on Measurements, Instrumentation and Traceability (SC-MINT) of the World Meteorological Organization (WMO) urges users to test selected samples of radiosondes under laboratory conditions to ensure that the calibrations supplied by the manufacturer are valid. Even if sensors can be produced in large batches to meet an agreed upon set of standardized performance checks, it is necessary for representative sensor samples, selected at random, to be checked more rigorously.^[8] This independent testing would further improve the reliability of radiosonde measurements by verifying the calibration results applied by manufacturers. While testing is crucial, the guide provided by SC-MINT only provides limited requirements for the test setup. These requirements describe the need for stability better than 1 %rh and systematic errors less than ± 1 %rh at the desired value. More detailed methodologies or test procedures for the testing of radiosonde humidity sensors in a relevant range of temperatures have not been reported.

The procedure presented in this document provides the technical requirements for the laboratory setup, the test procedure for errors in radiosonde humidity sensor calibration at relevant temperatures using the setup, and an evaluation method for the uncertainty of the test results.

Since calibration is valid at the time of calibration, this test may incorporate additional sources of uncertainty related to transportation and storage of the sensors, which could introduce additional uncertainty in the results. It's important to note that when considering uncertainty in soundings, other factors such as radiation dry bias and time-lag should also be considered, as summarized in Table 5 of Reference [3]. While all uncertainty terms affecting the results should be considered, the procedure in this document primarily focus on testing a subset of the uncertainty factors outlined in Reference [3], specifically those related to testing temperature-dependent calibration corrections. In uncertainty analysis, the uncertainty of the test setup, reference devices, and other potential uncertainties affecting radiosonde measurements under static conditions are included in this test.

The fundamental technique essential for this test involves the SI-traceable generation and/or measurement of water vapor pressure to determine the reference relative humidity and assess its associated uncertainty. Since humidity generators used in application of this document should be capable of producing multiple dew/frost-point temperatures below the test temperature, the testing of sensors at several relative humidity levels at the test temperature while avoiding condensation can be accomplished. An example for obtaining multiple dew/frost-point values is presented using a saturator-based humidity generator. This approach is chosen because of its traceability, and its documented validation by metrological and meteorological experts in testing radiosonde humidity sensors^[4-8].

It is worth noting that while the saturator-based technique is founded on Korean and US patents,^[9-11] the patent holder has granted a license, free of charge, to an unlimited number of applicants globally, without discrimination, and under reasonable terms and conditions. This license allows for the creation, use, and sale of implementations based on this ISO document. However, it's important to state that this ISO document is not solely based upon this patented technique. Alternative equivalent techniques, utilizing different types of humidity generators and/or precision hygrometers, can also be employed for determining reference relative humidity if they are SI-traceable and meet the specifications required under this document.

