



Standard Practice for QCM Measurement of Spacecraft Molecular Contamination in Space¹

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1. Scope

1.1 This practice provides guidance for making decisions concerning the use of a quartz crystal microbalance (QCM) and a thermoelectrically cooled quartz crystal microbalance (TQCM) in space where contamination problems on spacecraft are likely to exist. Careful adherence to this document should ensure adequate measurement of condensation of molecular constituents that are commonly termed “contamination” on spacecraft surfaces.

1.2 A corollary purpose is to provide choices among the flight-qualified QCMs now existing to meet specific needs.

1.3 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

1.4 *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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:²

E595 Test Method for Total Mass Loss and Collected Volatile Condensable Materials from Outgassing in a Vacuum Environment

E1559 Test Method for Contamination Outgassing Characteristics of Spacecraft Materials

2.2 U.S. Federal Standards:³

MIL-STD-883 Standard Test Method, Microcircuits

MIL-S-45743 Soldering, Manual Type, High Reliability Electrical and Electronic Equipment

FED-STD-209E Airborne Particulate Cleanliness Classes in Cleanrooms and Clean Zones

NOTE 1—Although FED-STD-209E has been cancelled, it still may be used and designations in FED-STD-209E may be used in addition to the ISO designations.

2.3 ISO Standards:⁴

ISO 14644-1 Cleanrooms and Associated Controlled Environments—Part 1: Classification of Air Cleanliness

ISO 14644-2 Cleanrooms and Associated Controlled Environments—Part 2: Specifications for Testing and Monitoring to Prove Continued Compliance with ISO 14644-1

3. Terminology

3.1 Definitions:

3.1.1 *absorptance*, α , n —ratio of the absorbed radiant or luminous flux to the incident flux.

3.1.2 *activity coefficient of crystal*, Q , n —energy stored during a cycle divided by energy lost during a cycle, or the quality factor of a crystal.

3.1.3 *crystallographic cut*, Φ , n —rotation angle between the optical axis and the plane of the crystal at which the quartz is cut; typically 35° 18' AT cut for ambient temperature use or 39° 40' cut for cryogenic temperature use.

3.1.4 *collected volatile condensable materials*, (CVC), n —tested per Test Method **E595**.

3.1.5 *equivalent monomolecular layer*, (EML), n —single layer of molecules, each 3×10^{-8} cm in diameter, placed with centers on a square pattern. This results in an EML of approximately 1×10^{15} molecules/cm².

3.1.6 *field of view*, (FOV), n —the line of sight from the surface of the QCM that is directly exposed to mass flux.

3.1.7 *irradiance at a point on a surface*, n — E_e , $E(E_e = dI_e/dA)$, (watt per square metre, Wm⁻²), ratio of the radiant flux incident on an element of the surface containing the point, to the area of that element.

¹ This practice is under the jurisdiction of ASTM Committee E21 on Space Simulation and Applications of Space Technology and is the direct responsibility of Subcommittee E21.05 on Contamination.

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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 U.S. Government Printing Office Superintendent of Documents, 732 N. Capitol St., NW, Mail Stop: SDE, Washington, DC 20401.

⁴ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036.