



Designation: F1869 – 16a

# Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride<sup>1</sup>

This standard is issued under the fixed designation F1869; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This test method covers the quantitative determination of the rate of moisture vapor emitted from below-grade, on-grade, and above-grade (suspended) bare concrete floors.

1.2 This test shall not be used to evaluate the rate of moisture vapor emitted by gypsum concrete or floors containing lightweight aggregate.

1.3 This test shall not be used to evaluate moisture vapor emissions over coatings on concrete or through reactive penetrants or over patching or leveling compounds.

1.4 This quantity of moisture shall be expressed as the rate of moisture vapor emission, measured in pounds of moisture over a 1000 ft<sup>2</sup> area during a 24-h period.

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

1.6 *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:*<sup>2</sup>

[E1745 Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs](#)

[E1993 Specification for Bituminous Water Vapor Retarders Used in Contact with Soil or Granular Fill Under Concrete Slabs](#)

[F141 Terminology Relating to Resilient Floor Coverings](#)

<sup>1</sup> This test method is under the jurisdiction of ASTM Committee F06 on Resilient Floor Coverings and is the direct responsibility of Subcommittee F06.40 on Practices.

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

2.2 *Resilient Floor Covering Institute Standard.*<sup>3</sup>

[Recommended Work Practices](#)

2.3 *Military Standard.*<sup>4</sup>

[MIL-PRF-131 Barrier Materials, Waterproof, Greaseproof, Flexible, Heat-Sealable](#)

2.4 *ICRI Guide.*<sup>5</sup>

[ICRI Technical Guideline 310.1-1997 Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays](#)

## 3. Terminology

3.1 *Definitions:* See Terminology [F141](#) for definitions of the terms, above-grade (suspended), below-grade, concrete, on-grade, and resilient flooring.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *moisture vapor emission rate (MVER)*—amount of water vapor in pounds emitted from a 1000 ft<sup>2</sup> area of concrete flooring during a 24-h period (multiply by 56.51 to convert to  $\mu\text{g/s m}^2$ ).

## 4. Significance and Use

4.1 Use this test method to obtain a quantitative value indicating the rate of moisture vapor emission from the surface of a concrete floor and whether or not that floor is acceptable to receive resilient floor covering. The moisture vapor emission rate only reflects the condition of the concrete floor at the time of the test. All concrete subfloors emit some amount of moisture in vapor form. Concrete moisture emission is a natural process driven by environmental conditions. All floor coverings are susceptible to failure from excessive moisture vapor emissions. The moisture vapor emitted from a concrete slab is measured in pounds. This measurement is the equivalent weight of water evaporating from 1000 ft<sup>2</sup> of concrete surface in a 24-h period. The calcium chloride moisture test has been the industry standard for making this determination and is a

<sup>3</sup> Available from Resilient Floor Covering Institute, 966 Hungerford Drive, Suite 12-B, Rockville, MD 20850.

<sup>4</sup> Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

<sup>5</sup> Available from International Concrete Repair Institute, International Concrete Repair Institute 3166 S. River Road, Suite 132, Des Plaines, IL 60018; [www.icri.org](http://www.icri.org)

practical, well-established and accepted test of dynamic moisture. It will produce quantified results directly applicable to flooring manufacturer's specifications. The results obtained reflect the condition of the concrete floor surface at the time of testing and may not indicate future conditions.

## 5. Apparatus

### 5.1 Test Unit Contents:

5.1.1 *Cylindrical Plastic Dish with Lid Containing Anhydrous Calcium Chloride*, heat sealed in a heat sealable bag meeting the latest version of MIL-PRF-131, Class 1 or 2, to protect from moisture intrusion.

5.1.1.1 Anhydrous calcium chloride shall be in the form of prilled beads and shall have a minimum purity of 94 %. Net weight of the anhydrous calcium chloride shall be  $16 \pm 1$  g.

5.1.1.2 Dish shall be made of a material that does not absorb moisture. Dimensions of the dish shall be  $2.7 \pm 0.08$  in. ( $69 \pm 2$  mm) outside diameter as measured at the bottom area of the dish that contacts the floor, 0.6 to 0.8 in. (15 to 20 mm) height without cover, wall thickness less than 0.08 in. (2 mm). Dish shall be supplied with a tight-fitting lid. The lid shall be secured to the dish with pressure-sensitive-adhesive backed vinyl tape that does not absorb moisture, or a mechanical seal shall be provided such as a screw-top or snap-top lid.

5.1.2 *Pressure Sensitive Label*, to be used to identify the container of calcium chloride and to record the date, time, and container weight when the test is started and completed.

5.1.3 *Transparent Cover*, with 0.5 in. (12 mm) flanges around the perimeter, approximately  $0.5 \text{ ft}^2$  ( $460 \pm 46 \text{ cm}^2$ ), as measured between the inside of the flanges, is required to seal the test area of the floor. The transparent cover shall have a depth greater than the height of the dish of anhydrous calcium chloride. The height of the transparent cover shall be 1.5 in.  $\pm$  0.125 ( $38 \pm 3.2$  mm).

5.1.4 *Strip of Sealant*, to secure the plastic cover to the floor in an airtight fashion.

5.1.5 *Brightly Colored Warning Label*, to be placed on the transparent cover as a protective warning while the test is being conducted.

5.1.6 *Optional Mailing Bag*, for the return of the sample to the party responsible for weighing the dish and calculating the test results.

5.2 *Gram Scale*, capable of measuring  $\pm 0.1$  g. This scale will be used to weigh the calcium chloride dish at the start and end of the test. On-site measurement is preferred to mailing the container back to the supplier for results.

5.3 *Thermometer*, capable of measuring room temperature.

5.4 *Hygrometer*, capable of measuring the relative humidity of the test site.

## 6. Conditioning

6.1 The test site should be at the same temperature and humidity expected during normal use. If this is not possible, then the test conditions shall be  $75 \pm 10^\circ\text{F}$  ( $23.9 \pm 5.5^\circ\text{C}$ ) and  $50 \pm 10$  % relative humidity. Maintain these conditions 48 h prior to, and during testing. For floors intended to be used at high or low temperatures or humidity (such as cold storage rooms), the test site must be within the temperature and

humidity range given above, not at the anticipated service temperature or humidity.

6.2 Prior to placement of the anhydrous calcium chloride tests, the actual test area shall be clean and free of all foreign substances. All residual adhesives, curing compounds, sealers, paints, floor coverings, etc. shall be removed. Removal shall be accomplished using approved OSHA work practices. For removal of existing resilient floorings or residual adhesive, strictly observe the Warning that follows and **Notes 1 and 2**. (**Warning**—Do not sand, dry sweep, dry scrape, drill, saw, beadblast, or mechanically chip or pulverize existing resilient flooring, backing, lining felt, or asphaltic cut-back adhesives. These products may contain either asbestos fibers or crystalline silica. Avoid creating dust. Inhalation of such dust is a cancer and respiratory tract hazard. Smoking by individuals exposed to asbestos fibers greatly increases the risk of serious bodily harm. Unless positively certain that the product contains non-asbestos material, presume it contains asbestos. Regulations may require that the material be tested to determine asbestos content. RFCI's recommended work practices are a defined set of instructions addressed to the task of removing all resilient floor covering structures whether or not they contain asbestos. When RFCI's recommended work practices are followed, resilient floor covering structures that contain (or are presumed to contain) asbestos can be removed in a manner that will comply with the current occupational exposure to asbestos standard's permissible exposure limits (PEL) issued by the Occupational Safety and Health Administrations (OSHA).

NOTE 1—Various federal, state, and local government agencies have regulations covering the removal of asbestos-containing material. If considering the removal of resilient floor covering or asphaltic cut-back adhesive that contains or is presumed to contain asbestos, review and comply with the applicable regulations.

NOTE 2—Certain paints may contain lead. Exposure to excessive amounts of lead dust presents a health hazard. Refer to applicable federal, state, and local laws and "Lead-based Paint: Interim Guidelines for Hazard Identification and Abatement in Public and Indian Housing"<sup>6</sup> regarding: (1) appropriate methods for identifying lead-based paint and removing of such paint, and (2) any licensing, certification, and training requirements for persons performing lead abatement work. (Use only qualified of certified lead abatement contractors to remove lead-based paint.)

## 7. Procedure

7.1 Do not re-test on a previously tested location. Remove floor coverings or coatings, if present. Lightly grind an area 20 by 20 in. (50 by 50 cm) to produce a surface profile equal to ICRI CSP-1 to CSP-2 (see ICRI Technical Guideline 310.1-1997). Grinding should remove a thin layer of the finished concrete but not expose coarse aggregate, unless the surface had been abrasively treated previously. A vacuum equipped with a suitable filter and grinder equipped with a dust shroud may be required to reduce airborne dust from grinding. Expose a minimum area of 20 by 20 in. (50 by 50 cm) to conditions specified in 6.1 and 6.2 for a minimum period of 24 h prior to starting each test. New concrete and/or concrete floors that have had floor coverings or coatings removed for at least 30

<sup>6</sup> Available from U.S. Department of Housing and Urban Development, Washington, DC. Use September 1990 or subsequent editions.

days prior to testing can be ground and tested without this waiting period, provided the conditions of 6.1 have been met.

7.1.1 Weigh the dish of anhydrous calcium chloride, including the tape used to seal the container, the container lid, and the label which should be affixed to the lid. Record the weight to the nearest 0.1 g on the container label along with the starting time to the nearest  $\pm \frac{1}{4}$  h.

7.1.2 If not provided by the  $\text{CaCl}_2$  (calcium chloride) test kit manufacturer, obtain the actual area of the test site. Measure the length and width of the plastic cover between the inside of the flanges, and multiply to obtain the area. Measure the bottom of the dish containing the  $\text{CaCl}_2$  to obtain the radius. To calculate the area of the dish, use the following equation:

$$A = \pi r^2 \quad (1)$$

where:

$$\pi = 3.14$$

Deduct the area of the dish from the area of the transparent cover. Record this as the actual test area. This will be used to make the final calculation at the end of the test.

7.2 Apply the sealant to the flanges of the transparent cover in a continuous bead. If the sealant has been preinstalled by the kit manufacturer, expose by peeling off the protective covering. The purpose of the sealant is to form an airtight seal around the perimeter of the transparent cover.

7.3 Carefully remove the sealing tape from the calcium chloride dish, if provided, and attach it to the side of the transparent cover. This tape will be used again to reseal the dish. Remove the dish lid and invert it under the dish. Set the dish (in the inverted lid) onto the concrete surface. (**Caution**—Do not spill any of the calcium chloride from the dish. If spillage occurs, discard the dish and perform the test with a new dish of anhydrous calcium chloride.

Immediately place the transparent cover over the calcium chloride dish. Firmly press down on the cover's flanges compressing the sealant providing an airtight seal around the cover.

7.4 After test has been in place for 60-72 h, remove the plastic cover. It may be best to cut the top open with a razor blade so the dish can be easily retrieved. Replace the lid on the dish and immediately reseal using the original sealing tape. Immediately reweigh the sealed container. Record the new weight, the date, and time the test was stopped. Record where test dish will be weighed if re-weighing is not performed at the test site.

NOTE 3—If test dish is to be return-mailed for results, immediately place in mailing bag ensuring bag is properly sealed. Follow mailing instructions provided with kit.

7.5 The formula for computing moisture vapor emission rate (MVER) is as follows:

$$\text{MVER} = \frac{24000 \cdot \Delta M}{453.612 \cdot A \cdot T} = \frac{52.91 \cdot \Delta M}{A \cdot T} \quad (2)$$

where:

MVER = moisture vapor emission rate, lb/1000 ft<sup>2</sup>/24 h,  
 $\Delta M$  = change in mass (weight gain) of anhydrous  $\text{CaCl}_2$  in g,  
 A = contact area of the flanged cover on concrete in ft<sup>2</sup> deducting the area of the  $\text{CaCl}_2$  dish, and  
 T = exposure time in hours.

7.6 To convert test results to SI, multiply by 56.51 to obtain results in  $\mu\text{g}/(\text{s m}^2)$ .

7.7 Use the following guidelines to determine the number of test locations to be utilized simultaneously.

7.7.1 Three test locations for areas up to 1000 ft<sup>2</sup> (100 m<sup>2</sup>).

7.7.2 Add one additional test for each 1000 ft<sup>2</sup> (100 m<sup>2</sup>) or fraction thereof.

NOTE 4—When conducting moisture emission tests, the test units should not be concentrated in an area but shall be located in various parts of the floor area. Tests shall be placed using the testing agent's judgment to represent areas of potential concern including the perimeter and center of the floor area.

## 8. Precision and Bias

8.1 Precision, characterized by repeatability  $S_r$ ,  $r$  and reproducibility  $S_R$ ,  $R$  has been determined for the following materials to be:

Material	Average	$S_r$	$S_R$	$r$	$R$
Concrete slab	5.94 lb/1000 ft <sup>2</sup> /24 h	0.24	0.32	0.68	0.90

8.1.1 This precision statement is provisional.

8.2 No information can be presented on the bias of the procedure in Test Method F1869 for measuring moisture vapor emission rates from concrete because no material having an accepted reference value is available.

## 9. Keywords

9.1 anhydrous calcium chloride; moisture vapor emission rate; quantitative calcium chloride; resilient flooring

**APPENDIX****X1. MOISTURE VAPOR RETARDERS****Non-Mandatory Information**

X1.1 Every floor slab-on-ground (on-grade or below-grade) should have a vapor retarder directly under the concrete that meets the requirements of the latest edition of Specification **E1745**, or Specification **E1993** installed in accordance with the recommendations of ACI 302.2R *Guide to Concrete Slabs that Receive Moisture-Sensitive Flooring Materials*.

X1.2 A moisture test indicates a condition of the concrete floor slab at the time of the test, under the ambient conditions

of the test, and may not predict the future moisture condition of the floor slab. This is especially true if an effective moisture vapor retarder is not present or has been compromised by damage or by improper installation. Ingress of moisture from subbase or subgrade soil can significantly increase the moisture condition of a concrete slab and potentially affect floor covering and adhesive performance when an effective vapor retarder is not present.

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