Designation: F710 – 11

Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring[1]

This standard is issued under the fixed designation F710; 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 practice covers the determination of the acceptability of a concrete floor for the installation of resilient flooring.

1.2 This practice includes suggestions for the construction of a concrete floor to ensure its acceptability for installation of resilient flooring.

1.3 This practice does not cover the adequacy of the concrete floor to perform its structural requirements.

1.4 This practice covers the necessary preparation of concrete floors prior to the installation of resilient flooring.

1.5 This practice does not supersede in any manner the resilient flooring or adhesive manufacturer's written instructions. Consult the individual manufacturer for specific recommendations.

1.6 Although carpet tiles, carpet, wood flooring, coatings, films, and paints ae not specifically intended to be included in the category of resilient floor coverings, the procedures included in this practice may be useful for preparing concrete floors to receive such finishes.

1.7 *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.* See 7.1, 7.1.1, and 7.1.2 for specific warning statements.

1.8 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.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C109/C109M Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens)

C472 Test Methods for Physical Testing of Gypsum, Gypsum Plasters and Gypsum Concrete

D4259 Practice for Abrading Concrete

D4263 Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method

D4397 Specification for Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications

E1155 Test Method for Determining F_F **Floor Flatness and** F_L **Floor Levelness Numbers**

E1486 Test Method for Determining Floor Tolerances Using Waviness, Wheel Path and Levelness Criteria

E1745 Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs

F141 Terminology Relating to Resilient Floor Coverings

F710 Practice for Preparing Concrete Floors to Receive Resilient Flooring

F1869 Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride

F2170 Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes

NOTE 1—Specifications and test methods for cements and other related materials are found in ASTM Volume 04.01. Specifications and test methods for concretes and related materials are found in ASTM Volume 04.02.

2.2 *ACI Guides:*[3]

302.1R-06 Guide for Concrete Floor and Slab Construction

117R Standard Tolerances for Concrete Construction and Materials

2.3 *Resilient Floor Covering Institute (RFCI):*[4]

Recommended Work Practices for the Removal of Resilient Floor Coverings

[1] This practice 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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[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 American Concrete Institute, 19150 Redford Station, Detroit, MI 48219.

[4] Resilient Floor Covering Institute, 966 Hungerford Drive, Rockville, MD 20850.

2.4 *Other Standards:*
MASTERSPEC Guide Spec Section 03 30 00 "Cast-In-Place Concrete"[5]

3. Terminology

3.1 *Definitions—* For definitions of terms used in this practice, see Terminology F141.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *mat,* as in "mat test"—a sample of vapor-retardant sheet resilient floor finish material or equivalent.

3.2.2 *moisture vapor emission*—a term used by the flooring industry in the U.S. to measure moisture emission from concrete floors in lb/1000 $ft^2 \cdot 24$ h (56.51 $\mu g/(s \cdot m^2)$) using the anhydrous calcium chloride test.

4. General Guidelines

4.1 The installation of a permanent, effective moisture vapor retarder with a minimum thickness of 0.010 in. and a permeance of 0.1 y, as described in Specification E1745 is required under all on- or below-grade concrete floors. The use of such a moisture vapor retarder, provided its integrity has not been compromised, reduces potential severity of water vapor penetration. Every concrete floor slab on- or below-grade to receive resilient flooring shall have a water vapor retarder (often improperly called a vapor barrier) installed directly below the slab.

4.2 The surface of concrete floors to receive resilient flooring shall be dry, clean, smooth, and structurally sound. They shall be free of dust, solvent, paint, wax, oil, grease, residual adhesive, adhesive removers, film-forming curing compounds, silicate penetrating curing compounds, sealing, hardening, or parting compounds, alkaline salts, excessive carbonation or laitence, mold, mildew, and other foreign materials that might affect the rate of moisture dissipation from the concrete, the adhesion of resilient flooring to the concrete or cause a discoloration of the flooring from below. Non-chemical methods for removal, such as abrasive cleaning or bead-blasting, including methods described in Practice D4259 may be used on existing slabs with deleterious residues.

4.2.1 **Warning**—Hydraulic cement used in concrete construction may contain trace amounts of free crystalline silica. Prolonged exposure to airborne free crystalline silica may be a health hazard. Avoid actions that cause dust to become airborne. Use local or general ventilation to control exposures below applicable exposure limits.

4.2.2 **Warning**—See 7.1.1 and 7.1.2 for warnings regarding asbestos and lead paint.

4.3 Surface cracks, grooves, depressions, control joints or other non-moving joints, and other irregularities shall be filled or smoothed with latex patching or underlayment compound recommended by the resilient flooring manufacturer for filling or smoothing, or both. Patching or underlayment compound shall be moisture-, mildew-, and alkali-resistant, and, for commercial installations, shall provide a minimum of 3000 psi compressive strength after 28 days, when tested in accordance with Test Method C109/C109M or Test Method C472, whichever is appropriate.

4.3.1 Joints such as expansion joints, isolation joints, or other moving joints in concrete slabs shall not be filled with patching compound or covered with resilient flooring. Consult the resilient flooring manufacturer regarding the use of an expansion joint covering system.

4.4 The surface of the floor shall be cleaned of all loose material by scraping, brushing, vacuuming, or other methods, or a combination thereof, as recommended by the resilient flooring manufacturer, immediately before commencing installation of resilient flooring.

4.5 Many resilient floorings may not be installed over concrete when residual asphalt adhesive residue is present. Consult the resilient flooring manufacturer's written recommendations concerning use of resilient flooring products in these situations.

4.6 Concrete floors shall be smooth to prevent irregularities, roughness, or other defects from telegraphing through the new resilient flooring. The surface of concrete floors shall be flat to within the equivalent of 3⁄16 in. (3.9 mm) in 10 ft, (as described in ACI 117R, or as measured by the method described in Test Method E1155 or any industry-recognized method specified) and within the equivalent of 1/32 in. (0.8 mm) in 12 in. (305 mm). See X1.7 for more information regarding flatness measurement methods.

4.7 *Acclimation*—Because of the role acclimation plays in a successful installation, most resilient flooring manufacturers recommend or require that their flooring products, sundry supplies (adhesives, coatings, welding rods, etc.) and the area to receive the resilient flooring are properly conditioned. Consult floor covering and sundry manufacturers for appropriate temperature and humidity range for the products to be installed and the geographic area where the job site is located. General recommendations are for the installation area and materials listed above to be maintained at a minimum of 65°F (18.3°C) and a maximum of 85°F (29.4°C) for 48 h before, during and for 48 h after completion of the installation. Relative humidity level extremes should also be avoided because of their influence on proper drying and curing of patching compounds and adhesives. General recommended humidity control level is between 35 – 55 %. If a system other than the permanent HVAC source is utilized, it must provide proper control of both temperature and humidity to recommended or specific levels for the appropriate time duration.

5. Testing Procedures

5.1 *Moisture Testing*—All concrete slabs shall be tested for moisture regardless of age or grade level. For the preferred moisture testing method and limits, consult the written instructions from the floor covering manufacturer, the adhesive manufacturer, the patching/underlayment manufacturer, or combination thereof. In the absence of manufacturer's guidelines, refer to Table 1.

5.1.1 Consult the resilient flooring manufacturer, the adhesive manufacturer, the underlayment manufacturer's written

[5] Available from MASTERSPEC, AIA Master Systems, King Street Station, 225 Reinekers Lane, Suite 215, Alexandria, VA 22314-2875.

TABLE 1 ASTM Test Methods for Concrete Moisture Reading

Test Method	Maximum Limit
F1869	3 lb/1000 ft^2 (170 $\mu g/m^2$) per 24 h
F2170	75 %

instructions, or combination thereof, for their acceptable test methods. If these instructions are in conflict, the most stringent requirements shall apply.

5.2 *pH Testing*—Concrete floors shall be tested for pH prior to the installation of resilient flooring. Levels of pH shall not exceed the written recommendations of the resilient flooring manufacturer or the adhesive manufacturer, or both.

5.2.1 To test for pH at the surface of a concrete slab, use wide range pH paper, its associated pH chart, and distilled or deionized water. Place several drops of water on a clean surface of concrete, forming a puddle approximately 1 in. (25 mm) in diameter. Allow the puddle to set for 60 ± 5 s, then dip the pH paper into the water. Remove immediately, and compare to chart to determine pH reading. Other pH testing methods such as pH pencils or pH meters, or both, are available and may be used to measure pH. Readings below 7.0 and in excess of 10.0 have been known to affect resilient flooring or adhesives, or both. Refer to resilient flooring manufacturer's written instructions for guidelines on acceptable testing methods and acceptable pH levels. See X1.4 for more information about pH levels in concrete slabs.

6. Preparation of New Concrete Floors

6.1 New concrete slabs shall be properly cured and dried or treated before installation of resilient flooring. Drying time before slabs are ready for moisture testing will vary depending on atmospheric conditions and mix design. See X1.3 for more information. Floors containing lightweight aggregate or excess water, and those which are allowed to dry from only one side, such as concrete over a moisture vapor retarder or concrete on metal deck construction, may need a much longer drying time and should not be covered with resilient flooring unless the moisture vapor emission rate or the percentage of internal relative humidity meets the manufacturer's installation specifications.

7. Preparation of Existing Concrete Floors

7.1 The resilient flooring manufacturer shall be consulted regarding the necessity of removal of old resilient flooring, adhesive residue, paint, or other surface contaminants. If old resilient flooring, paint, or adhesive residue is to be removed, follow 7.1.1 and 7.1.2:

7.1.1 **Warning**—Do not sand, dry sweep, dry scrape, drill, saw, beadblast, or mechanically chip or pulverize existing resilient flooring, backing, lining felt, paint, asphaltic cutback adhesives, or other adhesives. These products may contain 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 is a nonasbestos-containing material, presume that it contains asbestos. Regulations may require that the material be tested to determine asbestos content. The Resilient Floor Covering Institute's (RFCI's) recommended work practices for removal of existing resilient floor coverings should be consulted for a defined set of instructions addressed to the task of removing all resilient floor covering structures.

7.1.2 **Warning**—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 guidelines for hazard identification and abatement of lead-based paint published by the U.S. Department of Housing and Urban Development[6] regarding appropriate methods for identifying lead-based paint and removing such paint, and any licensing, certification, and training requirements for persons performing lead abatement work.

7.2 *Adhesive Removers*—There are a number of commercial adhesive removers that will properly remove adhesive residue from a subfloor, however, there are concerns that these products may adversely effect the new adhesive and new floor covering. The Resilient Floor Covering Institute's (RFCI's) recommended work practices for removal of existing resilient floor coverings and the resilient flooring manufacturer's written instructions should be consulted for a defined set of instructions which should be followed if existing adhesives must be removed.

8. Installation on Radiant Heated Floors

8.1 Most resilient flooring can be installed on radiant heated slabs providing the maximum temperature of the surface of the slab does not exceed 85°F (29°C) under any condition of use. Consult the resilient flooring manufacturer for specific recommendations.

9. Keywords

9.1 adhesive removers; cement; concrete floors; installation; moisture; moisture vapor emissions; pH testing; preparation; resilient flooring; rubber; slabs

[6] *Lead-Based Paint: Interim Guidelines for Hazard Identification and Abatement in Public and Indian Housing*, U.S. Department of Housing and Urban Development, Washington, DC, 1990.

APPENDIXES

(Nonmandatory Information)

X1. CONCRETE COMPOSITION AND PRACTICES

X1.1. *General* —X1.1 This brief information on concrete composition and practices is provided to help specifiers, resilient flooring installers, and resilient flooring manufacturers understand the properties of concrete. A concrete slab is not an inert substrate. It is a complex mixture of organic and inorganic substances whose properties and condition will affect the performance of a floor covering placed on its surface. Surface flatness, strength, joints, alkalinity, permeability, and many other concrete properties will have a significant effect on the long-term appearance and performance of resilient flooring.

X1.1.1 Concrete used for most floors is a mixture of hydraulic cement, fine aggregate (sand), coarse aggregate (stone), water and admixtures. In addition to these batch ingredients, chemical admixtures can be used to control the setting time, rate of strength development, workability, air entrapment, and other properties of concrete. For example, water-reducing admixtures can increase the slump of fresh concrete without adding additional water. Pozzolanic admixtures such as fly ash or ground granulated blast furnace slag are sometimes present as a partial replacement for the cement.

X1.1.2 Lightweight concrete, less than 115 lb/ft ^{3} (1841 kg/m^3), may have such low compressive strength that it is unsuitable for covering with resilient flooring unless 1 in. (25 mm) or more of standard weight concrete, generally 140 lb/ft^3 (2241 kg/m^3) or more, is used as a topping.

X1.2. *Water-Cement Ratio***—**X1.2 The most important factor affecting concrete properties is the water-cement ratio. This is the ratio of the mass of water to the mass of cement in a standard volume of concrete. For a given concrete mix design, as the water-cement ratio is increased, most concrete properties are affected negatively. Of special interest to the floor covering industry, compressive and flexural strengths are decreased, permeability is increased, and drying times are lengthened. Moderate to moderately low water-cement ratios (0.40 to 0.45) can be used to produce floor slabs that can easily be placed, finished, and dried, and which will have acceptable permeability to moisture. Floor slabs with water-cement ratios above 0.60 take an exceedingly long time to dry and cause adhesives or floor coverings, or both, to fail due to high moisture permeability.

X1.3. *Curing and Drying New Concrete***:**

X1.3.1 Freshly placed concrete sets and gains strength by the chemical reaction of water with the silicate and aluminate materials in the cement. As long as water is available during the planned curing period, the concrete will continue to gain strength and decrease its permeability. Various ways concrete is cured include cover curing with paper or plastic sheets or other methods which aid in retaining some moisture in the concrete, thus retarding the rate of drying. Resilient flooring and adhesive manufacturer's specifications often prohibit the use of membrane forming curing compounds as they can interfere with the bond of the adhesive to the concrete.

X1.3.2 Membrane forming curing compounds, in many cases, form a surface film of oil, wax, resins, or a combination thereof, that tend to lengthen the drying time of the concrete, obstruct the bond between the concrete surface and the adhesive and/or the patching or underlayment compound to the concrete, or may trap moisture in the concrete which will be released at a future date, or both, causing adhesive failure or other problems related to excess water vapor between the flooring and the slab. In all cases where curing compounds have been used, the resilient flooring or adhesive manufacturer, or both, shall be consulted.

X1.3.3 Excess water is always present beyond the amount of water required for cement hydration. As the cement continues to hydrate, excess water must be permitted to flow out of the concrete, generally by evaporation at the top surface, during a planned drying period following curing. A4 in. (100 mm) thick slab, allowed to dry from only one side, batched at a water-cement ratio of 0.45, typically requires approximately 90 to 120 days to achieve a moisture vapor emission rate (MVER) of 3 lb/1000 ft^2 (170 μg/m^2) per 24 h (the resilient flooring industry standard MVER). The importance of using a moderate to moderately low water-cement ratio for floors to receive resilient flooring cannot be overemphasized.

X1.4. *Alkalinity* —X1.4 As Portland cement hydrates, calcium hydroxide and other alkaline hydroxides are formed. The pH of wet concrete is extremely alkaline, typically around pH 12 to 13. The surface of a concrete slab will naturally react with atmospheric carbon dioxide to produce calcium carbonate in the hydraulic cement paste, which reduces the pH of the surface. Results in the range of pH 8 to 10 are typical for a floor with at least a thin layer of carbonation (approximately 0.04 in. (1 mm). Abrasive removal (shotblasting, sanding, or grinding) of a thin layer of concrete can remove this carbonated layer and expose more highly alkaline concrete below. Additional pH tests, waiting time, application of patching compound or underlayment, or a combination thereof, might be required after abrasive removal of the concrete surface. If the carbonated layer is removed and the pH of the concrete surface is above 10, consult the flooring and/or adhesive manufacturer for additional recommendations.

X1.5. *Efflorescence* —X1.5 Accumulation of salts on a concrete slab can be due to moisture movement vertically through the slab from bottom to top or horizontally inward from exposed edges of slabs on or below grade. Such salts can cause problems by destroying adhesive bond, displacing floor coverings, and staining. The most common efflorescence is a white powdery deposit of calcium carbonate which has a pH of close to neutral (7.0). Sulfate compounds can accumulate due to moisture migration, especially in parts of California. These compounds are not deleterious themselves but indicate that excessive moisture may be moving through the slab and should be addressed before installing a resilient floor covering.

X1.6. *Moisture Retarders***:**

X1.6.1 The installation of a permanent, effective moisture vapor retarder with a minimum thickness of 0.010 in., and a permeance of 0.1y, as described in Specification E1745 is required under all on- or below-grade concrete floors. The use of such a moisture vapor retarder, provided its integrity has not been compromised, reduces potential severity of water vapor penetration. Every concrete floor slab on- or below-grade to receive resilient flooring should have a water vapor retarder (often improperly called a vapor barrier) installed directly below the slab.

X1.6.2 Slab curling problems can arise when a slab dries at a differential rate – faster at the top while remaining wet at its lower surface. Curling is exacerbated by conditions such as hot, dry, windy weather following placement, inadequate curing, and excessively high water-cement ratio. Differential stresses due to shrinkage at the top and restraint at the bottom cause upward curling of the slab leading to uncontrolled cracking. Placing concrete directly on top of a moisture retarder reduces the possibility of outflow of excess batch water at the bottom of the slab, perhaps increasing the possibility of curling. Measurement of slab curling is not reflected in FF and FL measurements. See ACI 302.1R-06 for specific slab curling measuring techniques.

X1.7. *Flatness and Levelness of Concrete Floors to Receive Resilient Flooring***:**

X1.7.1 *History:*

X1.7.1.1 For over 50 years, concrete floor surface tolerances were typically measured and described by the maximum gap allowed under a 10-ft (3-m) long straightedge placed anywhere on the floor. This manual method was difficult, especially for large areas, and often results were deceptive, too stringent, and not reproducible. Clearly, a better measurement technique was needed.

X1.7.1.2 During the 1970s and 1980s, sophisticated instruments were developed to measure floor flatness, particularly in response to the need for producing superflat floors to control the sway of moving forklifts in warehouses with high storage racks and narrow aisles. There are two accepted measurement methods using such instruments today. One is described in Test Method E1155. The other measurement method is described in Test Method E1486.

X1.7.2 *The F-Number System:*

X1.7.2.1 The American Concrete Institute now recommends that flatness and levelness be described using the F-Number System as outlined in ACI 302.1R-06 and ACI 117R. This system identifies two numbers: F_F controls local surface bumpiness (or waviness) by limiting the magnitude of successive 1-ft (300-mm) slope changes. F_L controls overall levelness (or pitch) by limiting differences in the average of 10-ft (3-m) elevations along sample measurement lines.

X1.7.2.2 ACI 117R (commentary) states, "None of the conventional concrete placement techniques in use today can adequately compensate for form or structure deflections that occur during the concrete placement and, for this reason, it is inappropriate to specify levelness tolerances on unshored floor construction." For concrete slabs receiving resilient floor covering, therefore, it is most important to describe limits of floor flatness.

X1.7.2.3 As stated in ACI 302.1R-06, "In practice, F_F and F_L values generally fall between 12 and 45. The scale is linear, so that relative flatness/levelness of two different floors will be in proportion to the ratio of their F-numbers. For example, an F_F 30/F_L 24 floor is exactly twice as flat and twice as level as an F_F 15/F_L 12 floor." While there is no direct equivalent between F-numbers and straightedge tolerances, ACI 117R does give a rough correlation between the two systems, as shown in Table X1.1.

X1.7.3 *Guidelines for F-Number Subfloor Finish Tolerances Under Resilient Floors:*

X1.7.3.1 ACI 302.1R gives F-number results that can be achieved by following various slab construction procedures. It recommends that slabs to receive thin-set flooring with moderate or heavy traffic have composite flatness and levelness of F_F 35/F_L 25. However, it also advises that the selection of the

TABLE X1.1 Rough Correlations Between F-Numbers and Straightedge Tolerances

F-number (F_F)	Gap Under an Unleveled 10-ft (3-m) Straightedge
12	½ in. (12.7 mm)
20	5⁄16 in. (7.9 mm)
25	¼ in. (6.4 mm)
32	3⁄16 in. (4.8 mm)
50	⅛ in. (3.2 mm)

proper F_F/F_L tolerances for a new project is best made by measurement of a similar satisfactory existing floor.

X1.7.3.2 MASTERSPEC Guide Spec Section 03 30 00, Evaluations, has a guide to floor flatness and levelness tolerances for various floor use categories. It recommends a minimum F_F 20/F_L 17 for subfloors receiving thin coverings that will not mask the subfloor condition. Smooth, glossy, resilient flooring may require higher FF/FL values to minimize potential telegraphing.

X1.7.4 *Waviness Index*—Another more recent measurement method is described in Test Method E1486. This test method was developed primarily to measure floor surface wavelengths from 2 ft (600 mm) to 10 ft (3 m)—those that most affect forklift rideability at typical speeds on floors designed for random vehicular traffic. Proponents of this test method have submitted proposed guidelines to ACI Committee 117 suggesting tolerance standards. These guidelines include the recommendation that concrete floors with vinyl tile covering be specified with a surface waviness index (SWI_{2-10}) of 0.10 in. (2.5 mm). This is approximately equivalent in the tested area to F_F 28/F_L 20 and to a ¼-in. (6.4-mm) gap permitted under a 10-ft (3-m) straightedge.

X1.7.5 *Remedial Measures*—ACI 302.1R-06 identifies precautions, influencing factors, construction environment, and measurement timeliness relative to maintaining flatness and levelness tolerances. It suggests: "Remedial measures for slabs on ground might include grinding, planing, surface repair, retopping, or removal and replacement. For suspended slabs, remedial measures are generally limited to grinding or use of an underlayment or topping material. Contract documents should clearly identify the acceptable corrective methods(s) to be used."

X1.7.6 *Limitation of Measurement Methods:*

X1.7.6.1 One important reason for specifying flatness tolerance for concrete slabs to receive resilient floor tile is to attempt to minimize tile runoff and gapping due to slab surface waviness. F_F numbers and waviness index numbers necessary to accomplish this have not been determined. However, experience shows that floors with a maximum ¼-in. (6.4-mm) gap under an unleveled 10-ft (3-m) straightedge tend to lessen the tendency for tile runoff.

X1.7.6.2 Thin, applied resilient floor coverings can exhibit show-through of very small subfloor irregularities and roughness. Methods that indicate surface flatness by measuring elevations at 12-in. (300-mm) or larger increments cannot reflect surface imperfections that occur at smaller intervals. Only visual inspection will show surface defects such as concrete trowel marks, small protrusions, or pits. Resilient flooring finishing techniques and products that give increased glossiness will accentuate the telegraphing of such subfloor unevenness or texture. Therefore, specifications for slabs to receive resilient flooring should address the issue of small-scale smoothness, even if only from a qualitative point of view.

X2. SYNAPSIS OF OTHER METHODS OF EVALUATING MOISTURE CONDITIONS OF CONCRETE FLOORS TO RECEIVE RESILIENT FLOOR COVERINGS (formerly contained in E1907)

X2.1. Summary of Section

X2.1.1 This section describes four procedures, commonly referred to as "tests," or "practices" used in the construction industry to provide an indication of the presence of moisture. These procedures are non-mandatory. They may assist in screening for potential moisture issues. Section 5 of this document contains the current industry accepted procedures to quantify moisture acceptability of a concrete slab to receive resilient flooring.

X2.1.2 Unless otherwise indicated, these practices are applicable to slabs on grade, slabs below grade, and slabs above grade (see Terminology F141).

X2.2. Polyethylene Sheet Test

X2.2.1 *Summary of Method*—This method uses a vapor-retardant plastic sheet sealed to the floor as a vapor trap to determine if excessive moisture is present. This method is described by Test Method D4263.

X2.2.2 Although developed for coating systems preparation, it is also sometimes used in the flooring industry.

X2.2.3 *Materials:*

X2.2.3.1 Transparent polyethylene sheet, Specification D4397, minimum 4 mils (0.1 mm) thick.

X2.2.3.2 Adhesive tape that will adhere to the floor and the sheet, such as duct tape, 2 in. (50 mm) wide.

X2.2.4 *Procedure:*

X2.2.4.1 Tape a plastic sheet approximately 18 by 18 in. (460 by 460 mm) tightly to the concrete surface making sure all edges are sealed.

X2.2.4.2 After a minimum of 16 h,[7] remove the plastic sheet and inspect the underside of the sheet and the concrete surface for presence of moisture.

X2.2.5 *Calculation and Interpretation of Results*—Presence of visible liquid water indicates concrete is insufficiently dry for application of finishes. However, lack of visible liquid water does not ensure that the concrete is sufficiently dry for the application of finishes. Quantitative testing Per F710 is necessary.

X2.3. Mat Test

X2.3.1 *Summary of Method:*

X2.3.1.1 This method uses a sample of vapor retardant floor finish material and a water-based adhesive to predict the behavior of resilient floor covering adhesives over a limited time period.

[7] Although Test Method D4263 specifies 16 h, some authorities recommend a minimum of 24 h.

X2.3.1.2 A variation of this procedure (known as the short term "bond" test) beyond the scope of this document can be used to test for bond between substrate and resilient floor coverings.

X2.3.2 *Materials:*

X2.3.2.1 Latex multipurpose or water soluble adhesive intended for use with resilient flooring products. It is not necessary to use the type of floor finish product intended for application in this procedure, since the sheet product simply provides a vapor-retardant surface which has sufficient rigidity and weight to remain in place during the procedure.

X2.3.2.2 Sheet vinyl, or similar resilient vapor-retardant resilient flooring sheet product.

X2.3.2.3 Adhesive tape that will adhere to the floor and the sheet, such as duct tape, 2 in. (50 mm) wide.

X2.3.3 *Preparation*—Prepare number of mats as required approximately 24 by 24 in. (600 by 600 mm).

X2.3.4 *Procedure*—Apply adhesive to an area 24 by 24 in. (600 by 600 mm). While the adhesive is wet, place the mat, surface or face down, immediately into the adhesive. Seal the perimeter edges using tape. The face is placed down to avoid absorption of water in the adhesive by the backing.

X2.3.5 *Calculation or Interpretation of Results:*

X2.3.5.1 After 72 h, make a visual inspection to determine the condition of the adhesive.

X2.3.5.2 If the adhesive is partially or completely dissolved, is still wet, or has little bond, there is too much moisture present to proceed with the installation of flooring material.

X2.3.5.3 If the mat is firmly bonded or removal of the mat reveals the adhesive to be stringy and with good adhesion, the level of moisture present may be low enough that quantification of moisture level per Section 5 is in order.

X2.4. Electrical Resistance Test

X2.4.1 *Summary of Method*—Determines the relative moisture content by measuring the electrical conductivity of concrete between the meter probes.[8] Conductivity varies in proportion to moisture content. Uses proprietary meters and interpretive methods provided by meter manufacturers. This procedure provides a relatively quick way to obtain an approximation of the relative moisture content of concrete.

X2.4.2 *Apparatus*—Suitable instrument to measure the conductivity between two electrodes which are placed in contact with the concrete floor surface or placed into two pre-drilled holes 1 in. (25 mm) deep into the concrete floor.

X2.4.3 *Preparation, Calibration and Standardization of Apparatus*—Follow instrument manufacturer's instructions.

X2.4.3.1 To use one type of instrument, it is necessary to drill holes in the slab to receive pins. Another type can be used with or without drilling holes, but the readings will be more accurate if holes are drilled and the pins are driven into the holes. Care shall be taken to avoid contact between the probes and any metal incorporated into the slab.

X2.4.4 *Calculation or Interpretation of Results:*

X2.4.4.1 Generic data to correlate measured electrical resistance to acceptable moisture conditions are not available at this time; however, instrument manufacturers generally publish guides for this purpose specific to the instruments they manufacture. When results indicate potential high moisture level, quantify results per Section 5.

X2.4.4.2 Although a high reading (good conductance) typically indicates high relative moisture content, a low reading (poor conductance) does not necessarily indicate more than surface dryness, as the concrete may have a higher relative moisture content below the surface. Conversely, a concrete with low relative moisture content but containing metal fibers could cause a high reading.

X2.4.4.3 Confirmation measurements can be made by taking readings at a number of locations which are then covered by a vapor retarder material such as polyethylene sheeting, then taking subsequent readings 24 h later after removing the covers. Where the second reading significantly exceeds the first, it indicates that the concrete may have a high MVER.

X2.5. Electrical Impedance Test

X2.5.1 *Summary of Method*—Uses proprietary meters and interpretive methods provided by meter manufacturers to determine the relative moisture content of concrete by measuring both conductance and capacitance. A non-destructive way to determine the potential relative moisture content of concrete is by measuring the electrical AC impedance. Impedance is an alternating current measurement combining both resistance and capacitance while at the same time overcoming the separate limitations of each (single-line measurement with resistance and shallow depth of penetration of signal with capacitance). With impedance measurement, a field is set up consisting of an area under the footprint of the instrument electrodes. The depth of the signal penetration will vary depending on the material content of the slab and the relative moisture content, generally varying from 0.75 in. (20 mm) to 2.0 in. (50 mm).

X2.5.2 *Apparatus*—An electrical impedance meter specifically developed and calibrated for concrete moisture measurement.

X2.5.3 *Preparation, Calibration and Standardization of Apparatus*—See instrument manufacturer's instructions.

X2.5.4 *Procedure*—Follow instrument manufacturer's instructions. Typically, the meter is placed on the concrete slab with its electrodes pressed in direct contact with the surface. When the meter is switched on, low frequency signals are transmitted into the slab, measuring the change in impedance brought about by potential moisture. The impedance is converted to a moisture reading displayed on the instrument dial. Holes in the slab are typically not required.

X2.5.5 *Calculation or Interpretation of Results*—See instrument manufacturer's instructions. Instructions for calibration of instruments are provided by instrument manufacturers. Readings typically indicate potential moisture.

[8] The most detailed information on this test comes from British Standards Institution (BSI) BS 5325:1983 British Standard Code of Practice for Installation of Textile Floor Coverings and BS 8203:1987 British Standard Code of Practice for Installation of Sheet and Tile Flooring.

X3. EFFECTS OF MOISTURE

X3.1. Introduction

X3.1.1 The effect on floor coverings from residual moisture in concrete slabs or moisture passing through concrete slabs from underlying soil has been understood and documented prior to the early 1950s when the RMA (Resilient Manufacturers Association) developed a moisture test method widely adopted by the flooring industry.[9]

X3.1.2 Concrete floors may appear dry from a visual examination but actually have a deleterious level of water vapor in, emitting from, or passing through a slab.

X3.2. Adverse Impacts

X3.2.1 Excessive water or water vapor in or emitting from concrete slabs can result in the following adverse impacts:

X3.2.1.1 Adhesive failure.

X3.2.1.2 Spalling and cratering of concrete surfaces. As moisture emits from or passes through a slab, it can carry with it alkaline salts from the ground or the concrete itself which are left behind as the water evaporates. The vapor from salt-bearing ground water is incapable of carrying salts through the concrete, but alkaline salt can build up cyclically at the top of the slab profile due to chemically-pure vapor attracting salts through osmosis.

X3.2.1.3 Fungal growth and odors.

X3.3. Design and Construction-Related Sources of Excessive Water in Concrete Floors

X3.3.1 *Artificial sources*—are typically caused by construction or operation of a building, such as:

X3.3.1.1 *Irrigation*—Mitigate by considering planting that requires low water use and minimizing watering. Exterior grading should provide good runoff or percolation.

X3.3.1.2 *Service conditions,* such as frequent floor cleaning wash-downs. Mitigate by modifying maintenance requirements or providing a waterproof barrier between finish and slab.

X3.3.2 *Natural sources*—are those that existed at the site prior to construction but may be exacerbated by the design of the building or the construction process.

[9] Resilient Floor Covering Institute (RFCI) Addressing Moisture Related Problems Relevant to Resilient Floor Coverings Installed Over Concrete (Rockville, MD: Resilient Floor Covering Institute, November 1995). p. 6.