~~Designation:C794–06~~ Designation: C794 – 10

Standard Test Method for Adhesion-in-Peel of Elastomeric Joint Sealants[1]

This standard is issued under the fixed designation C794; 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.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope

1.1 This test method covers a laboratory procedure for determining the strength and characteristics of the peel properties of a cured-in-place elastomeric joint sealant, single- or multicomponent, for use in building construction.

1.2 The values stated in metric (SI) units are to be regarded as the standard. The values given in parentheses are provided for information only.

1.3 The committee with jurisdiction over this standard is not aware of any comparable standards published by other organizations.

1.4 *This standard does not purport to address all of the safety problems, 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:*~~

~~C33Specification for Concrete Aggregates~~

~~C109/C109MTest Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens)~~

~~C150Specification for Portland Cement~~ ASTM Standards:[2]

C717 Terminology of Building Seals and Sealants

~~C1442Practice for Conducting Tests on Sealants Using Artificial Weathering Apparatus~~

~~G113Terminology Relating to Natural and Artificial Weathering Tests of Nonmetallic Materials~~ 1375 Guide for Substrates Used in Testing Building Seals and Sealants

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

E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

3. Terminology

3.1 The definitions given in Terminology C717 ~~on terms relating to building seals and sealants and in Terminology G113 on terms relating to natural and artificial weathering tests are applicable to this test method.~~ on terms relating to building seals and sealants are applicable to this test method.

4. Summary of Test Method

4.1 This test method consists of preparing test specimens by embedding a ~~strip of cloth in a~~wire mesh screen between two thin layers of the sealant being tested, on ~~several substrate materials,~~ test substrates, curing these specimens ~~for a certain length of~~ under specified time ~~under specified~~ and conditions, then placing the specimen in a tension-testing machine in such a way that the embedded ~~cloth~~ wire mesh screen is peeled back from the substrate at 180°, ~~and~~while measuring the force exerted as well as the ~~nature~~mode of ~~the separation~~failure of the sealant from the substrate.

5. Significance and Use

~~5.1There are differences in opinion among those concerned with sealant technology whether or not this adhesion-in-peel test is intended to simulate the conditions encountered by a sealant in normal use. Nevertheless, since it represents a test to destruction, the value of the test denotes the ability of the cured sealant to maintain a bond to the substrate under severe conditions.~~

[1] This test method is under the jurisdiction of ASTM Committee C24 on Building Seals and Sealants and is the direct responsibility of Subcommittee C24.30 on Adhesion.

Current edition approved Sept. ~~15, 2006.~~1, 2010. Published ~~September 2006.~~October 2010. Originally approved in 1975. Last previous edition approved in ~~2001~~2006 as C794 – 0~~1~~6. DOI: 10.1520/C0794-1~~0~~6.

[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.

~~5.2Many sealant manufacturers utilize the adhesion-in-peel test for determining the adhesive characteristics of sealant/primer combinations with unusual or proprietary substrates.~~

5.1 There are differences in opinion among those concerned with sealant technology whether or not this adhesion-in-peel test simulates the type of strain and e-tensile stresses encountered by a sealant in normal use. Nevertheless, this test provides a valuable measurement of the ability of the cured sealant to maintain a bond to the substrate under severe peel conditions.

5.2 Many sealant manufacturers utilize the adhesion-in-peel test for determining the adhesive characteristics of sealant/primer combinations with unusual or proprietary substrates. This test is especially useful for quality measurements comparing batches of the same sealant relative to adhesion or for studying adhesion of a given sealant to a variety of substrates.

5.3 This test method alone is not appropriate for comparing the overall performance of different sealants in a given application. The adhesive force that determines if a given sealant is useful in a given application also depends on the modulus of elasticity and the degree to which the sealant will be strained. This test, as it exists, does not consider the modulus of elasticity, nor amount of stress that will be produced by a given strain in an actual sealant in a moving joint. No known correlations are given to relate and apply modulus values to the peel values.

5.4 This test requires that the results indicate whether the failure mode is primarily adhesive or cohesive. It is important to note that a cohesive failure is not necessarily better than an adhesive failure, if the adhesive value is sufficient for the application. Having adhesive failure allows one to study the change of adhesion with time and with the various stress conditions.

6. Apparatus and Materials

6.1 *Tensile Testing Machine* with tension grips capable of pulling at the rate of separation of ~~51~~ approximately 50 mm (2 in.)/min, and having a chart indicator calibrated in ~~0.45-kg (1-lb)~~0.45-N (0.1-lbf) units.

6.2 *Standard Substrates*~~:~~

~~6.2.1*Aluminum Alloy*, Type 6063-T5 or 6061-T6, with a clear anodized finish of not less than 0.0075-mm (0.3-mil) thickness over a scale-free finish; 2 pieces, 152 by 76 by 6.3 mm (6 by 3 by ¼ in.).~~

~~6.2.2*Mortar Slabs*, prepare two cement mortar slabs, each 152 by 76 by 9.5 mm (6 by 3 by ⅜ in.) in size, using one part of high early strength Portland cement conforming to Type III of Specification C150 for Portland Cement, to two parts by weight of clean, uniformly graded, concrete fine aggregate (sand) conforming to Specification C33, for Concrete Aggregates. Use sufficient water to produce a flow of 100 ± 5 when tested in accordance with the procedure for the determination of consistency of cement mortar described in Test Method C109/C109M. After curing 1 day in moist air and 6 days in saturated lime water at 23 ± 2°C (73 ± 3°F), prepare the surface of 152 by 76 mm (6 by 3 in.) of each slab by wet grinding either side with a belt sander using No. 60 aluminum carbide sanding belt or using an iron lap with No. 60 silicon carbide (or aluminum oxide) grain until the aggregate is uniformly exposed. Return the slabs to saturated lime water storage until needed.~~

~~6.2.2.1Slabs may be prepared and shipped to other locations for use. The slabs may be shipped dry and shall be returned to saturated lime water storage on arrival until needed.~~

~~6.2.2.2Prior to use, wet grind the previously ground surface to remove any laitance, rinse thoroughly under running tap water, and dry the slabs overnight at 105 to 110°C (220 to 230°F). Clean the slabs by vigorous brushing with a stiff-bristled fiber brush to remove any film or powder. Condition the slabs at standard conditions for not less than 1 day and not more than 7 days.~~

~~6.2.3*Plate Glass*, polished, clear, 152 by 76 by 6.3 mm (6 by 3 by ¼ in.).~~

~~NOTE1—Because of the fact that adhesive properties of a joint sealant are related to the nature of the substrate, it is strongly recommended that whenever possible the peel test be made with the substrates that are to be used in the building under consideration in addition to or in place of the specified substrates described in 6.2.1, 6.2.2, and 6.2.3. Such substrates include brick, marble, limestone, granite, stainless steel, plastic, quarry tile, and others. For practical reasons the specimen dimensions may be changed from the standard sizes provided the thickness of the sealant remains as specified.~~

~~6.3*Spacer Strips*, four, of hard wood, metal, or glass as follows: two 152 by 76 by 6.3 mm (6 by 3 by ¼ in.) for preparing the test specimens on aluminum and glass, and two of the same length and width but 9.3 mm (⅜ in.) thick for preparing the test specimens on mortar.~~ —This test method may be performed on a wide variety of substrates. See Guide C1375 for a description of standard substrates and recommended surface preparation. Since adhesive properties of a joint sealant are related to the nature of the substrate, it is strongly recommended that whenever possible that adhesion-in-peel testing be performed on substrate samples that are representative of the building materials. Examples of such substrates include brick, marble, limestone, granite, aluminum, stainless steel, plastic, ceramic tile, and others.

6.3 *Masking Tape*, paper, roll, 25 mm (1 in.) wide.

6.4 ~~*Glass Rod*, about 12.7 mm (½ in.) in diameter and about 305 mm (12 in.) long.~~ Wire Mesh Screen[3] stainless steel or aluminum, 20-mesh, 0.4 mm (0.016 in.) wire thickness, cut to a width of 25 + 0, -2 mm (1.0 + 0, -0.08 in.) by a minimum length of 250 mm (10 in.). The wire mesh screen selected must be flexible yet strong enough to not tear during adhesion-in-peel testing. The wire mesh screen must be flat and free of kinks. To ensure adhesion of the joint sealant to the wire mesh, thoroughly clean the screen prior to use. Sealant primer on the wire mesh screen is generally recommended by the sealant manufacturer to enhance adhesion of the joint sealant to the screen. Sealant may also be pre-applied to the screen to enhance adhesion.

~~[3] Available from Reeves Brothers, Inc., 1271 Ave. of Americas, New York, NY 10020.~~

[3] Available from Tetko Inc., 333 South Highland Ave., Briarcliff Manor, NY 10510. Also available from McMaster Carr Supply Co., P.O. Box 4355, Chicago, IL 60680.

6.4.1 *Discussion*—Adhesion of the joint sealant to the mesh screen is essential to evaluate adhesion-in-peel properties of the sealant to the substrate. Due to the unique characteristics of each sealant, the sealant manufacturer must determine for each sealant the appropriate screen composition, mesh dimension, wire diameter and screen cleaning and priming procedure. Polyester mesh, fiberglass mesh, airplane cloth, fabric, plastic film or similar material can be used in lieu of a wire mesh provided that the material is pliable, of a thickness no greater than 0.5 mm (0.02 in.), does not adversely affect sealant cure and does not rupture during adhesion-in-peel testing.

6.5 ~~*Stainless Steel or Brass Rods*, two, 1.6 mm (1⁄16 in.) in diameter, about 305 mm (12 in.) long.~~ Tooling Device—aluminum or similar rigid material, created to produce a 2 mm (0.08 in.) by 25 mm (1 in.) sealant bead and 4 mm (0.16 in.) by 25 mm (1 in.) sealant bead after tooling (Fig. 1). The width of the tooling device may be up to 27 mm (1.06 in.) to allow easy tooling of the sealant without snagging the edges of the screen.

6.6 ~~*Masking Tape*, paper, roll, 25.4 mm (1 in.) wide.~~

~~6.7*Airplane/Wire Cloth* Grade A, desized, 4.28 oz/yd, 80/84 count, 6 pieces at least 178 mm (7 in.) long and 76 mm (3 in.) wide, or suitable wire cloth,[4] 30-mesh, 0.254-mm (10-mil) thickness.~~

~~6.8*Putty Knife*, stiff, about 38 mm (1½ in.) wide.~~

~~6.9~~ *rigid, approximately 40 mm (1.6 in.) wide.*

6.7 *Knife*, with sharp razor-type blade.

~~6.10*Exposure Apparatus*—The exposure apparatus shall be one of the three types of laboratory accelerated weathering devices described in Practice C1442, that use either xenon arc, fluorescent UV or open flame carbon arc radiation. Consult Practice C1442 for the differences in test parameters among the devices. Because of differences in test conditions, test results may differ with the type of device used. The choice of device shall be by mutual agreement among the interested parties.~~

7. Test Specimens and Cure Procedures

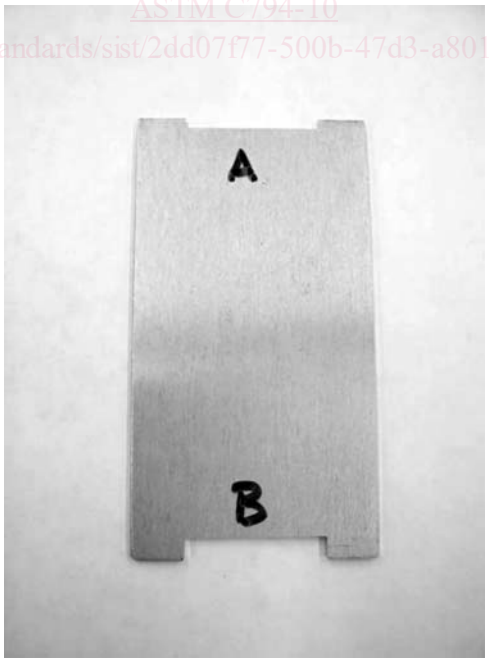
~~7.1Two test specimens shall be prepared on aluminum, two on cement mortar, two on glass, and two on each of any other substrate materials specified, using the following procedures:~~

~~7.1.1Condition not less than 250 g of sealant (and sufficient portion of other components, if a multicomponent) in a closed container for 24 h at 23 ± 2°C (73.4 ± 3.6°F) and 50 ± 5% relative humidity.~~

~~7.1.2Clean the test surfaces of all metal and glass substrates with methyl ethyl ketone or similar solvent followed by a thorough cleaning with a detergent solution (Note 3), a final rinse with distilled or deionized water, and air dry. Clean masonry surfaces with a dry stiff fiber bristle brush.~~

~~7.1.3Apply primer to the clean dry test surfaces only when specified and supplied by the sealant manufacturer and agreed upon by the purchaser.~~

~~7.1.4Place a strip of masking tape 25 mm (1 in.) wide across the test surface of the substrate so that the lower edge of the tape~~



NOTAGES—A – 25 by 2 mm (1 by 0.08 in~~-th.~~) inde ~~Prepn~~taration ~~of the Adhes~~
B – 25 by 4 mm (1 by 0.16 ~~ion-~~.) in~~-P~~deel Tesnt ~~Spec~~atimeon

FIG. 1 Special Tooling Device

~~is parallel and at least 76.2 mm (3 in.) from the lower short edge of the substrate (~~

7.1 Four test specimens (adhesion-in-peel samples) shall be prepared on each of the substrates using the following procedures:

7.1.1 Condition a minimum of 250 g of sealant for 24 h at 23 ± 2°C (73 ± 4°F) and 50 ± 5 % relative humidity. Multi-component sealants will require mixing for 5 min or as recommended by the sealant manufacturer. Specific mixing equipment and mixing procedures may be recommended by the sealant manufacturer.

7.1.2 Unless specified otherwise, standard conditions of temperature and relative humidity used throughout this test method are defined as 23 ± 2°C (73 ± 4°F) and 50 % relative humidity.

7.1.3 Clean and prepare the substrate samples as described in Guide C1375. Substrate materials not described in C1375 should be prepared in accordance with the sealant manufacturer's recommendations.

7.1.4 Apply primer(s) to the substrate(s) if recommended by the sealant manufacturer.

7.1.5 Masking tape can be applied to the substrate surfaces adjacent to the test area to allow easy removal of excess joint sealant.

7.1.6 Wire mesh screens must be thoroughly cleaned and primed, if required, as recommended by the sealant manufacturer.

7.1.7 For each substrate preparation/cleaning condition to be tested, apply a bead of sealant at least 100 mm (4 in.) in length to the substrate surface (Fig. 2).

7.1.8 Immediately place the wire mesh screen on the sealant bead and lightly tap it into the joint sealant (Fig. 3).

7.1.9 Holding the screen with a finger to prevent slippage, gently draw down the sealant imbedding the wire mesh into the wet sealant, using the special tooling device – side A (Fig. 1~~A~~*) at an 90° angle to the substrate (Fig. 4). The wire mesh screen should be imbedded to a uniform depth of 2 mm (0.08 in.) from the substrate surface (Fig. 5).*

~~7.1.5Spread a portion of the conditioned compound, after being mixed thoroughly for 5 min (if multicomponent), over the 102 by 76-mm (4 by 3-in.) area, which includes the masking tape, to a depth slightly more than 1.6 mm (1⁄16 in.), as shown in Fig. 1*B*.~~

~~7.1.6Smear one piece of cloth with the compound at one end over an area of 102 by 76 mm (4 by 3 in.), forcing it into both sides of the cloth with a putty knife until the sealant has thoroughly penetrated the cloth.~~

~~7.1.7Lay the impregnated cloth over the layer of compound and place the spacer bars of proper thickness (see 6.3) on each side of the specimen.~~

~~7.1.8Place a 1.6-mm (1⁄16-in.) metal rod lengthwise on top of each spacer strip and squeegee the compound to 1.6 mm (1⁄16 in.) thick by rolling the glass rod over the metal rods (starting from the taped end), and simultaneously pressing on the cloth and sealant beneath it. Trim off the excess amount that is squeezed out (Fig. 1*C*~~

7.1.10 Immediately apply a second bead of joint sealant over the first bead of sealant and wire mesh screen (Fig. 6).

~~7.1.9Cure the specimens containing multicomponent compounds 14 days at 23 ± 2°C (73.4 ± 3.6°F). Cure those containing single component compounds 21 days as follows (Note 4): 7 days at 23 ± 2°C (73 ± 3.6°F), 50 ± 5% relative humidity; 7 days at 37.8 ± 2°C (100 ± 3.6°F) and 95 ± 5% relative humidity; and finally 7 days at 23 ± 2°C (73 ± 3.6°F) and 50 ± 5% relative humidity.~~

~~7.1.10After the specimen has cured for about 7 days, coat the cloth with a layer of the compound about 1.6 mm (1⁄16 in.) thick to help minimize cloth failure (Fig. 1*D*~~

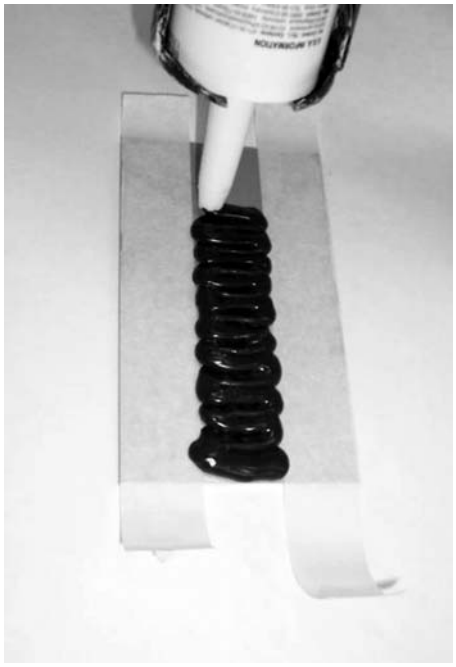


FIG. 2 First Sealant Bead Applied to Substrate (with masking tape)

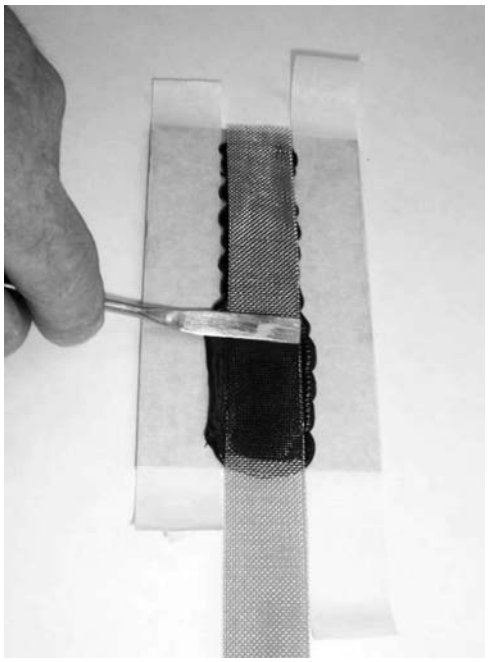


FIG. 3 Wire Mesh Screen being Imbedded in Wet Sealant Bead

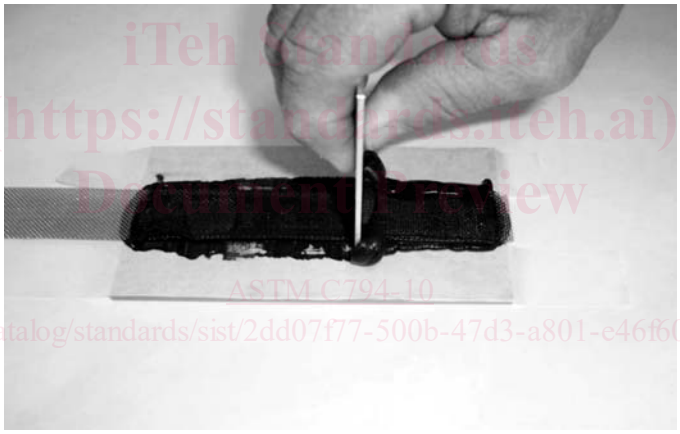


FIG. 4 Tooling Sealant after Imbedding Wire Screen Mesh with Special Tooling Device – Side A

7.1.11 Again holding down the screen with a finger to prevent slippage, use the special tooling device – side B (Fig. 1) and draw down the sealant at a 90° angle to the substrate. The total depth of the sealant should be 4 mm (0.16 in.) (Fig. 7) and the wire mesh screen should be imbedded uniformly at the approximate midpoint of the total sealant depth.

7.1.12 Excess sealant beyond the edge of the wire mesh screen may be removed while the sealant is wet using a putty knife or spatula. Avoid moving the screen imbedded in the sealant. Masking tape, if used, should be removed at this time.

7.1.13 After the sealant is cured, excess sealant may be carefully removed along the length of the test sample using a razor knife. Fig. 8 shows a final prepared adhesion-in-peel test sample.

7.1.14 Allow the sealant to cure as recommended by the sealant manufacturer. Standard curing time is 21 days at standard conditions. Curing time and conditions may vary depending on the sealant type and application.

8. Test Procedure

8.1 Once the sealant is fully cured, gently wrap the loose end of the wire mesh screen and bend back. Using a razor knife, provide a fresh cut along the sealant to the substrate interface (Fig. 9).

~~7.1.11Immediately following the full curing period (see 7.1.9 and Note 4), make four cuts with a sharp blade lengthwise of the specimen, cutting completely through to the substrate surface, and remove excess material so as to leave two 25.4-mm (1-in.) wide strips of cloth-covered sealant separated by a space about 9.5 mm (⅜ in.) wide (Fig. 1*E*) (7.1.12). **Caution**—Extreme caution should be taken in removing the excess material so that the sealant/substrate bond in the test strips is not disturbed.~~

~~7.1.12If peel adhesion is to be tested on glass substrate specimens after ultraviolet exposure through glass, after completing step~~

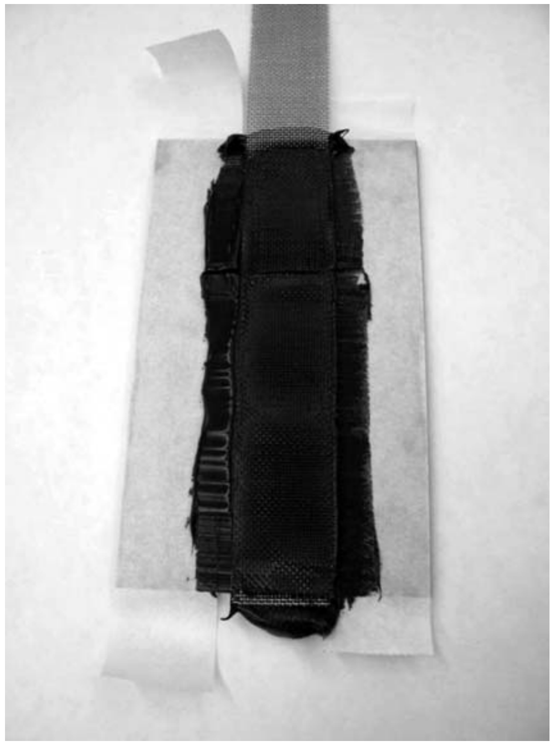


FIG. 5 Adhesion-in-Peel Test Specimen after Imbedding Wire Mesh Screen

FIG. 6 Applying Second Bead of Sealant

~~7.1.11 and before proceeding with 7.1.13, place the specimens in the weathering device with the sealant surface facing away from the light source. Test conditions in each type of device are in accordance with the procedures in C1442, Section 7 on Apparatus, except that the xenon arc and open flame carbon arc devices shall be operated without the water spray. Expose the specimens for 200 h and then continue as stated in 7.1.13~~

8.1.1 Place the test specimen in the tensile testing machine with the substrate secured to the fixed member and the loose end of the wire mesh screen secured to the movable member at an angle of 180° (Fig. 10).

8.1.2 Pull the screen at a rate of 50 mm (2 in.)/min for a total of 1 min (Fig. 11).

8.1.2.1 If the screen breaks during the testing, disregard the value. If possible, undercut the sealant with a razor knife and repeat the test. If the screen continues to break, prepare new test samples using a higher strength wire mesh screen.

8.1.2.2 If the sealant peels away cleanly from the screen, disregard the value. Undercut the sealant with the razor knife and repeat the test. If adhesive failure to the screen continues, prepare new test samples using a more thoroughly cleaned or primed, or both, wire mesh screen. If necessary, use a material other than a wire mesh screen.

8.1.2.3 If the adhesion-in-peel test sample shows adhesive failure to the screen in two repeated attempts but peel force values are above the specified requirements, further sample testing may not be required. In such cases, report failure mode as screen