



ANSI/SPRI VR-1 2018
**Procedure for Investigating Resistance to Root
or Rhizome Penetration on Vegetative Roofs**

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Disclaimer

This standard is intended for use by architects, engineers, roofing contractors, and owners of low-slope roofing systems. SPRI, its members and employees do not warrant that this standard is proper and applicable under all conditions.

1.0 Purpose of This Standard

This standard is intended for testing the resistance of the *root barrier* component used in vegetative roof assemblies to normal *root* or *rhizome* penetration.

2.0 Scope

The test described in this standard has been developed to evaluate plant growth and the ability of a *root barrier* to resist normal *root* or *rhizome* penetration. This test is based on the FLL "Procedure for Investigating Resistance to Root Penetration at Green Roof Sites." The FLL procedure was developed in Germany and is based on findings and testing experience of evaluations of various materials over a number of years. This test is intended to build on this experience and provide an equivalent evaluation protocol for North American test sites.

This procedure includes testing of the *root barrier*, seams, edges and all methods of attachment. The test standard excludes any component material within the vegetative roof assembly not being exposed to *roots* or *rhizomes*.

The test is intended to evaluate the *root barrier's* resistance as a physical barrier. *Root barriers* based on chemical inhibitors may be evaluated using this procedure; however, it should be noted that the procedure is not suitable for evaluating long-term chemical stability or long-term performance of these barriers.

The findings for any *root barrier* which has been tested shall not apply with plants with strong *root* or *rhizome* growth (e.g. Bamboo or Chinese Reed varieties). When using such plants, additional measures shall be taken and special care shall be specified by the designer of record.

The test procedure does not evaluate waterproofing ability, environmental compatibility, or long-term stability (i.e. temperature changes, UV light, microbial attack, etc.) of the *root barrier*. (See C2.0)

3.0 Definitions

All words defined within this section are italicized throughout the standard. The following definitions are used in this document:

3.1 Root Barrier

Any material intended to prevent penetration of *root* or *rhizome* growth.

3.2 Trial Container

A container with specified minimum dimensions to be used for the growing of plants, the examination of the *roots* or *rhizomes*, and where the installed *root barrier* will be tested. (See 5.4)

3.3 Growth Media

An engineered formulation of inorganic materials including but not limited to, heat-expanded clays, slates, shales, aggregate, sand, perlite, vermiculite, as well as organic materials including but not limited to, compost worm castings, coir, and peat. The formulation and installation of *growth media* with the *trial container* shall offer water and air management properties to promote plant growth. It shall be given fertilization for optimum development of the test plants. (See 5.7 and 5.8) The *growth media* shall be in direct contact with the *root barrier* to be tested.

3.4 Root or Rhizome

Since the evaluation differentiates between *roots* or *rhizomes*, a reliable determination of these subterranean plant organs is indispensable. The following indications serve as a basis for the evaluation:

- ▶ *Roots* vary in thickness and show several branches. Leaves never form, and *roots* are not hollow. (See 4.1 *Pyracantha Coccinea* "Orange Charmer" and Figure 1)
- ▶ *Rhizomes* expanding in the *growth media* show a regular thickness of approximately 0.79 in (20 mm) and few branches. They are divided into

different sections with knots forming the boundaries between the sections. Around the knots inconspicuous small leaves surrounding the stem as well as thin *roots* have formed. In between the knots the couch grass *rhizomes* are hollow (See 4.1 *Elymus Repens* “Couch Grass” or “Quack Grass” and Figure 1)

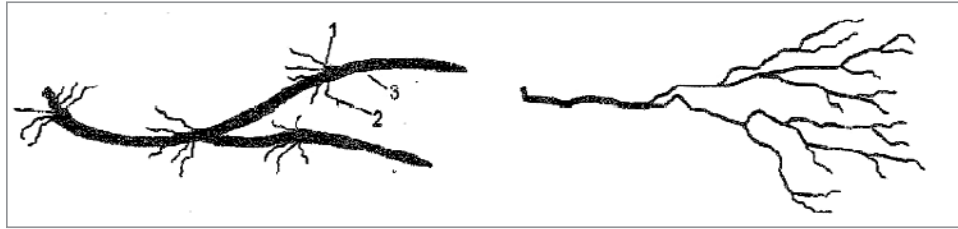


Figure 1: Schematic representation Of “Couch Grass” *rhizome* (left) with knots (1), *roots* (2) and leaves (3). “Orange Charmer” *root* (right).

4.0 Test Plant Growth

4.1 Plants

- ▶ ***Pyracantha Coccinea***: “Orange Charmer” a woody ornamental plant species which under greenhouse conditions shows an all-year round growth suitable for the test.
- ▶ ***Elymus Repens* (aka *Agropyron Repens*)**: “Couch Grass or Quack Grass”, an indigenous grass with slow-growing *rhizomes*, a common weed species found on many roofs with a moderately aggressive rhizomatous growth habit and which also grows sufficiently all-year under the given testing conditions.

4.2 Classification of Plant Growth Coverage Performance

Plant growth coverage shall be visually evaluated monthly with the following scale:

- Inadequate: <60% surface coverage
- Moderate: 60–75% surface coverage
- Adequate: >75% surface coverage

4.3 Plant Growth Coverage

Within 3 months of the onset of the test, plant growth coverage of the media shall be in excess of 60% of the surface, and there shall be evidence of new growth and plant *roots* or *rhizomes* shall be visible at the bottom of the control containers. Plant growth coverage shall remain dense (>75% surface coverage and a dense mat of *roots* or *rhizomes* at the bottom of the control containers) throughout the remainder of the test procedure (Figure 2). If <60% plant growth coverage is not attained after 3 months terminate and restart the test, or wait until 60–75% coverage is attained. The test duration shall be extended to account for the delay in achieving 60–75% coverage. This condition shall be noted in the test report. *Root* or *rhizome* surface coverage shall be determined using the methodology presented in Section 6.1.

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Figure 2: Adequate healthy plant growth (>75% coverage) in a trial container and dense root mat visible at the bottom of a control container.

5.0 Testing Procedure

5.1 Description of the Procedure

The test shall be conducted in a climate-controlled greenhouse with environmental conditions maintained to promote continuous year-round growth of *Pyracantha* or *Elymus*. The standard procedure is 2 years to ensure 24 months of active plant growth. Test periods longer than 24 months may be warranted to evaluate long-term stability of radicide materials. Plant growth procedures at individual test sites shall be modified based on local environmental conditions to ensure aggressive plant growth. However, in no instance shall the test have duration of less than 21 months after the requisite 60% *root* or *rhizome* surface coverage is achieved (See 4.3). Any modification from the standard procedure and the reason for the modification shall be noted in the test report.

Plants installed in a commercial greenhouse or nursery *growth media* in the *trial containers* with dense planting, moderate fertilization and modest watering obtain the desired vigorous growth and high *root* or *rhizome* pressure for evaluation. (See Sections 5.4, 5.6, 5.7 and 5.8).

At the evaluation at the end of the trial, the *growth media* shall be removed from the container and the *root barrier* shall be examined to detect *root* or *rhizome* penetration or adhesion (See 6.3). Control samples of any *root barrier* tested shall be saved and stored in a dark location at an average temperature of 77°F (25°C) ± 5° for comparative examination at the end of the trial.

5.2 Testing Location

A greenhouse equipped with heating and ventilation facilities shall be provided. The heating system shall be set to 65°F (18°C) ± 5° during the daylight hours and 60°F (15°C) ± 5° at night. Ventilation set points shall be 75°F (24°C) ± 5° during the daylight hours and 70°F (21°C) ± 5° at night. Maximum daylight or night temperature shall not exceed 122°F (50°C) ± 5° or be above 104°F (40°C) ± 5° for more than 1 hour. Minimum daylight or night temperature shall not be less than 45°F (7°C) ± 5°. Adequate space shall be provided to ensure that all containers can be accessed to be evaluated and maintained.

Supplemental lighting shall be used to augment natural light where winter day length or light intensity results in less than 6 moles per square meter per day monthly average irradiance between 400 and 700 nm. Sufficient supplemental light shall be applied to bring the daily total irradiance to a minimum of 6 moles per square meter per day. This shall be accomplished by using indoor plant grow lights. Lights shall use a minimum 7200°K full spectrum bulb which promotes overall plant growth. This can be obtained by high CRI fluorescent lamps or Metal Halide to better stimulate average North Sky. Lights shall be placed no more than 2 ft (0.6 m) from the plant material in the *trial containers*. Lights shall operate on 12-hour cycles until natural lighting conditions improve.

5.3 Test Duration

Following setup, the test shall run for a minimum of 24 months of equivalent plant growth.

5.4 Trial Containers

Trial containers shall provide adequate space to install the *root barrier* to be used. The minimum internal dimensions of the containers used in the trial shall not be less than 32 in x 32 in x 10 in (800 mm x 800 mm x 250 mm). (See C5.4)

Trial containers shall be fitted with transparent bases (e.g., acrylic glass) so that *root* or *rhizome* penetration can be detected even during the test phase without interfering with the *growth media*. (Figure 3)

For each *root barrier* to be tested, six *trial containers* shall be used. In addition, per experimental run—regardless of the number of *root barriers* to be tested—three control containers (without any *root barrier*) shall be provided.



Figure 3: Sample trial container. Note the interior metal fold to support the clear Plexiglas base.

5.5 Root Barrier to be Tested

The *root barrier* shall be supplied and installed in the *trial containers* per the manufacturer's specifications and shall contain seams or joints as shown in Attachment 1 and Attachment 2. The *root barrier* shall be laid according to Section 5.11. Liquid coating *root barriers* shall be applied according to Section 5.11.1.

5.6 Growth Media

Growth media shall be a greenhouse or nursery product commercially available or composed onsite. When a commercial product is used the manufacturer and lot number shall be recorded. If composed onsite, the formulation shall be recorded. EC and pH will be measured using a standard saturated paste method. (See C5.6)

5.7 Fertilizer

Fertilization by liquid feed or slow release fertilizer with complete macro and micro-nutrients shall be used to encourage plant and *root* or *rhizome* growth. Fertilizer shall be applied at the low or moderate rate recommended by the fertilizer manufacturer for containers of the size used to maximize plant growth. Formulations and quantities of fertilizer applied shall be recorded and included in the final report. (See C5.7)

5.8 Irrigation

Plants shall be watered with good quality water suitable for greenhouse or nursery crop production. Plants shall be watered as needed based on local environmental conditions to maximize plant growth. Irrigation may be done by hand or by an automated system. In either case plants shall be allowed to dry between irrigation applications, and the *growth media* shall be thoroughly wetted with each irrigation application.

5.9 Samples and Information Provided by the Manufacturer

To ensure a clear identification of the tested product, the following information shall be provided by the manufacturer before the test is started: product name, material description, material standards, thickness, surface finish or structure, test certificates, year of manufacture, seaming or jointing procedures (e.g. spacing overlap, seaming technique, seaming agents, type of seam sealing, cover strips over seams, special corner and angle joints), and, if applicable, admixture of biocides (e.g. *root* inhibitors) with details regarding the concentration of the substances.

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5.10 Preparation and Installation of the Trial Container

Trial containers shall be prepared with the following layered superstructure (from bottom to top), plexiglass *trial container* base, *root barrier* to be tested, *growth media*, plantings.

After the installation of the *root barrier* (See 5.11) to be tested, the *trial containers* shall be flood tested for 12–24 hours to ensure the waterproofing of the *trial container*.

The *growth media* shall be added to the *trial container* and compacted to a course depth of 5.9 in \pm 0.39 in (150 mm \pm 10 mm). (See C5.10)

Four pieces of *Pyracantha Coccinea* per *trial container* of 32 in x 32 in (800 mm x 800 mm) shall be planted equally spread over the entire surface. Also, 0.07 oz (2 g) of seeds or 8–10 *rhizome* plugs of *Elymus Repens* shall be equally sown or planted uniformly in the *growth media* in each container.

If larger *trial containers* are used, the number of plants and the quantity of seeds or plugs shall be increased so that at least the same plant density is reached.

5.11 Application of Root Barrier

Cut out the parts of the *root barrier* to be tested and lay them as required into the *trial containers*. Execute four seams at the corners where the walls meet, two seams along the base at the corners and one T-seam running along the middle. All *root barriers* must be installed per manufacturer's published requirements. (Attachment 1 and Attachment 2).

5.11.1 Application of Liquid Coating Root Barrier

The coating shall be brought up to the upper rims of the container walls. Seams or overlaps shall be included in the *trial container* installation for liquid applied materials equivalent to those described in Section 5.11. If the material being tested has minimum and maximum recoat windows, seams shall be created both within and outside the recoat window following the manufacturer's recommended procedures for each and outlined in Figure 4.

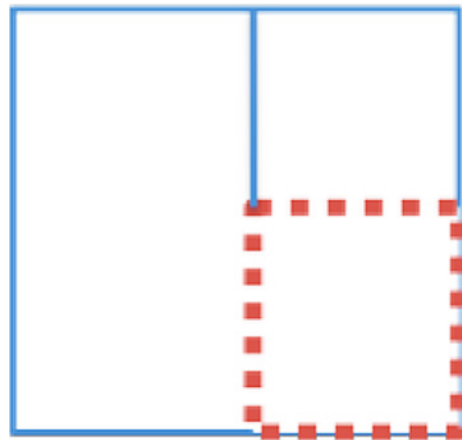


Figure 4: Seam or overlap pattern for liquid coating root barriers. Solid lines indicate seams and corners created within the recoat window. Dashed line indicates seams created outside the manufacturer's recommended recoat window.

5.12 Care of the Plants During the Growth Period

The *growth media* moisture content shall be set according to the needs of the plants by means of top watering onto the *growth media*. The grower at the test site shall visually evaluate water requirements every 1–3 days and irrigate as needed. Sufficient water shall be applied at each irrigation to thoroughly wet the *growth media* and to ensure a good germination and rooting of the plants in the first eight weeks after the greening process.

Dead plants shall be replaced during the first 3 months of the investigation. If during the course of the investigation the losses in terms of plants account for more than 25% of the total plant number installed in more than 2 of the 6 *trial containers* the test shall be terminated and repeated.

Maintain plants to aid in proper growth management. Pruning shall be kept to a minimum because excessive pruning will limit *root* growth. Pruning shall be done equally to both test and control plants. (C5.12)

Insufficient quack grass coverage (< 40% of the surface is covered) shall be improved by up to two units of repeat seeding or by dividing existing plants or adding additional *rhizome* plugs in the first three months of the test.

In case of pest attacks or plant diseases threatening the survival of the plants under testing, appropriate plant protection measures shall be carried out. Pesticide applications if necessary shall be kept to a minimum and the chemical class of the pesticides shall be carefully considered with the *root barrier* manufacturer to avoid the use of materials that might interact with the *root barrier* material.

5.13 Preparation and Installation of the Three Control Trial Containers

Control *trial containers* shall be prepared and installed as described in Section 5.0, but without the installation of the *root barrier* material.

6.0 Evaluations

6.1 Evaluation During Testing

See Section 5.12 for proper irrigation and plant management. Plant damage such as deformations of the leaves or changes of leaf color shall be noted.

Inspection of all *trial containers* (test and control containers) shall be made once a month. This observation shall include visual evaluation of plant cover, plant appearance, new growth, and *root* or *rhizome* surface growth coverage at the bottom of the control *trial containers*. (See 4.2). A digital photograph of all *trial containers* (base and plants) shall be taken during this inspection. (See C6.1)

A formal evaluation of the transparent base of the 6 test *trial containers* shall be conducted in intervals of 6 months to detect for visible *roots* or *rhizomes* penetration.

6.2 Premature Test Termination

If in the course of the test evaluations visible penetrations of *roots* or *rhizomes* into the *root barrier* to be tested is identified, the test shall be terminated. (See 4.6)

If during the test phase more than 25% of the plants are lost, the investigation shall be started anew, i.e., new plantings with new *growth media* shall be carried out.

6.3 Evaluation at the End of the Trial

6.3.1 Evaluation Procedure

Evaluation commences with a final monitoring of the growth performance of the plants. Above-ground plant biomass for test *trial container* and control *trial container* shall be compared per below instructions.

After the above ground biomass has been removed and evaluated the *trial containers* shall be turned upside down and the *growth media* and *root* or *rhizome* mass removed.

In a successful test the entire *growth media* mass will be completely bound together by *roots* or *rhizomes* and will come out of the test *trial container* as a single mass. *Root* or *rhizome* density at the bottom of the containers shall be evaluated when the boxes are disassembled. *Root* or *rhizome* density at the bottom of the test *trial containers* shall be visually compared with *root* or *rhizome* density of the control *trial containers*. Successful plant growth is indicated by a solid mat of *roots* or *rhizomes* at the bottom of the control *trial containers*. *Root* density at the bottom of the control *trial containers* of less than 80% observed indicates poor test conditions and the test shall be repeated.

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After plant and *root* or *rhizome* evaluations, examine the *root barrier* material for *root* or *rhizome* adhesion or penetration. Wash with garden hose using gentle pressure to remove loose material. Examine remaining material to determine if *roots* or *rhizomes* have adhered to the surface of the *root barrier*. Examine under a 7x magnification microscope to determine if they are surface attached or have penetrated into the *root barrier*. *Root* or *rhizome* ingress or penetration into the *root barrier* shall be recorded in the test report. (See C6.3).

6.3.2 Test Field Evaluation

If more than 50 *roots* or *rhizomes* per container are found to have penetrated into but not through the *root barrier*, the evaluation on penetration shall be performed only on a section of the tested material. In this case, the evaluation shall cover at least 2 ft² (0.2 m²) equivalent to about 20% of the *root barrier* covered with the *growth media*, and shall be performed in the area indicated in (Figure 5). The penetration of *roots* or *rhizomes* into the field of the evaluation area shall be recorded.

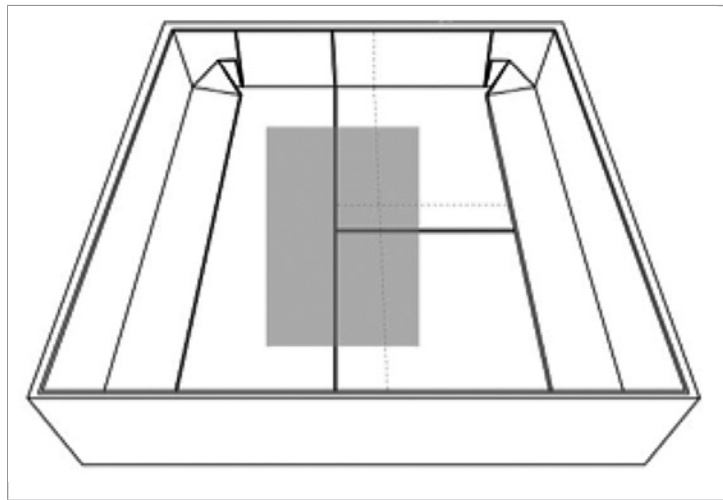


Figure 5: Evaluation of penetrations into the surface of the *root barrier* with >50 penetrations per receptacle.

6.3.3 Test Seam Evaluation

The penetration of *roots* or *rhizomes* into the overlap area of seams shall be recorded. For retention purposes, samples of the *root barrier* shall be taken. The samples shall be compared to the control samples stored at the initial stage of the testing. (See 5.1)

6.3.4 Failure Criteria

A *root barrier* is deemed to have failed if *roots* or *rhizomes* have penetrated through the *root barrier* or seams in the *root barrier* material and are visible at the bottom of the *trial container* (Figure 6).

Figure 6: Root penetration on backside of tested *root barrier*.



6.4 Test report

Upon termination of the trial, a complete test report shall be prepared. The report shall contain the following information:

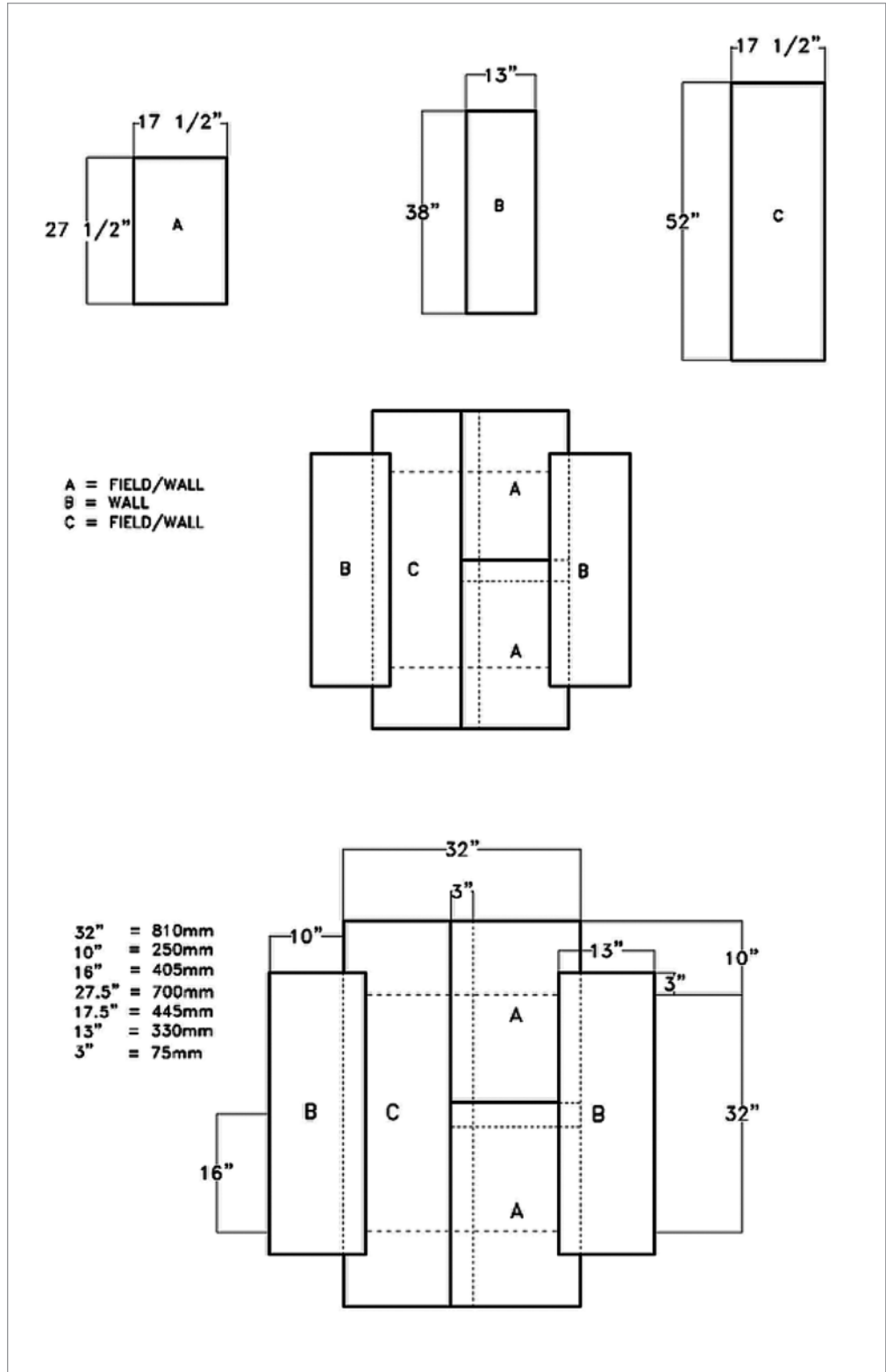
- ▶ Details provided by the manufacturer in relation to the *root barrier* under testing. (See 5.9);
- ▶ Description of the preparation of the *trial containers*; and
- ▶ All evaluation results in accordance with Section 6.0.

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Attachments

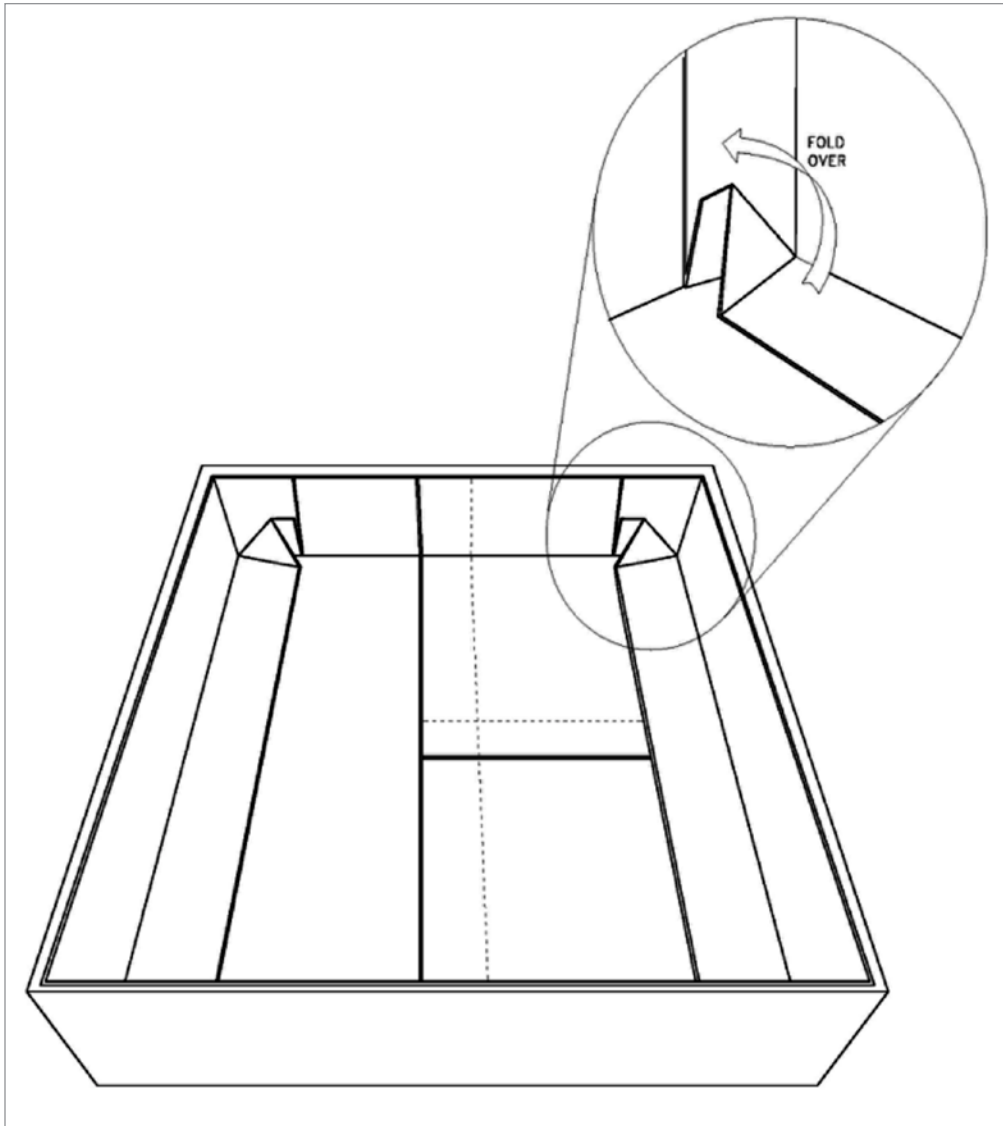
Attachment 1: Layout of the seams in the root barrier to be tested



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Attachment 2: Trial container corner detail



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Commentary

This Commentary is not a part of ANSI/SPRI VR-1 Procedure for Investigating Resistance to *Root* or *Rhizome* Penetration on Vegetative Roofs. It is included as supplemental information.

This Commentary consists of explanatory and supplementary material designed to assist users in applying the recommended requirements. It is intended to create an understanding of the requirements through brief explanations of the reasoning employed in arriving at these requirements. The following wording shall be included in introduction to the Commentary: "The information contained in this Commentary is not part of this American National Standard (ANS) and has not been processed in accordance with ANSI's requirements for an ANS. As such, Commentary may contain material that has not been subjected to public review or a consensus process. In addition, it does not contain requirements necessary for conformance to the standard."

The sections of this Commentary are numbered to correspond to sections of the standard to which they refer. Since it is not necessary to have supplementary material for every section in the standard itself, there may be gaps in the numbering in the Commentary.

C2.0 The goal of this test procedure is to maximize *root* or *rhizome* growth in contact with the *root barrier* being tested. The two moderately aggressive and vigorous plant species chosen represent a realistic threat to *root barrier* integrity when well grown. Plant growth procedures described in this test are intended to maximize *root* or *rhizome* growth.

C5.4 Larger containers may be used if the circumstances under which they are to be installed so require. For example, a larger *trial container* would be needed to evaluate seaming details as they would be installed in the field.

C5.6 Examples of commercially available *growth media* are Premier Horticulture Pro-Mix BX, Quebec, or other equivalent media. The substrate will require about 23 gal (88 L) per receptacle (taking into account a substrate supply via plant earth-clumps).

C5.7 An example of commercially available fertilizer is Osmacote Plus 15-9-12 with a release over 6 months.

C5.10 This corresponds to a substrate volume of 23 gal (88 L) for a receptacle of 32 in x 32 in (800 mm x 800 mm) It is advisable to place the receptacles on stands to facilitate *root* or *rhizome* penetration checks in regular intervals. Keep a minimum distance of 16 in (0.4 m) between and around the different receptacles.

C5.12 Pruning is limited to side shoots if they are an obstacle to using walkways. Excessive pruning will limit *root* or *rhizome* growth.

C6.1 To evaluate the *root* or *rhizome* surface growth coverage of the control *trial containers*, a digital photograph may be taken of the transparent base. The photograph can be processed at high contrast in order to highlight *root* or *rhizome* covered areas. The *root* or *rhizome* density as a percentage of total base area can be determined using appropriate image processing software.

C6.3 *Root* or *rhizome* adhesion is defined as *roots* or *rhizomes* that stick to the surface of a material or imperfections in the surface of a material that are not easily washed off with a low pressure water stream. This may include *roots* or *rhizomes* that have entered surface air bubbles or craters in the surface of a material but not progressed beyond the limits of the surface imperfection. *Root* or *rhizome* adhesion does not include *roots* or *rhizomes* that stick to the material because of surface erosion or other degradation of the material.

Not to be identified as *root* or *rhizome* penetration but may be noted in the test documentation are:

- ▶ *Roots* or *rhizomes* that have grown < 0.2 in (5 mm) on a root barrier which contain radicide substances, since here any root or *rhizome* banning effect can only act upon the root or *rhizome* in the root barrier.
- ▶ *Roots* or *rhizomes* that have penetrated seam sealing components (without damaging the sealed seam).