Designation: F1900 – 98 (Reapproved 2012)

An American National Standard

Standard Test Method for Water Resistance of Footwear Using a Walking Step Simulator[1]

This standard is issued under the fixed designation F1900; 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 test method covers a method of measuring the water resistance of footwear.

1.2 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D2098 Test Method for Dynamic Water Resistance of Shoe Upper Leather by the Dow Corning Leather Tester

D2099 Test Method for Dynamic Water Resistance of Shoe Upper Leather by the Maeser Water Penetration Tester

2.2 *SATRA Test Method:*[3]

Physical Test Method PM81 Trough-Water Penetration Test

2.3 *FIA Test Methods:*[4]

No. 1209, Appendix B—Whole Shoe Flex in Water

3. Significance and Use

3.1 Water resistance is a desirable characteristic for many different types of footwear. This test method provides a guide for measuring water resistance under dynamic conditions that closely duplicate normal human walking. The degree of correlation between this test and footwear performance in the field or footwear performance in the SATRA Trough-Water Penetration Test has not been fully determined.

4. Apparatus

4.1 *Mechanism*, such as the one shown in Fig. 1, that approximates the movements and forces involved in human walking motion. The important features of the walking motion produced by the mechanism are defined as follows:

4.1.1 At the beginning of a step (the point where the heel of the footwear touches the walking surface) the leg pylon attached to the prosthetic foot shall form an angle of 16 ± 5° (relative to a line perpendicular to the walking surface) as shown in Fig. 2.

4.1.2 At the end of a step (the point where the toe of the footwear departs from the walking surface) the leg pylon shall form an angle 31 ± 5° (see Fig. 2).

4.1.3 Each step shall begin with no force being exerted on the footwear and with the footwear not in contact with the walking surface. When the footwear contacts the walking surface, it shall remain in contact during the entire support phase of the step and then depart from the walking surface at the end of the step.

4.1.4 During the support phase of each step, a downward force shall be applied to the footwear to simulate the weight of the user. The force shall equal one bodyweight of the typical prospective user, with a tolerance of ±10 %, unless a different force is specified. Table 1 lists the body masses of 50th percentile adults and children, and the equivalent one bodyweight downward force levels. If no other downward force is specified, the values in Table 1 shall be used.

NOTE 1—The force under the prosthetic foot can be measured with a load cell or force plate.

4.2 *Men's 26-cm (U.S. Size 9) or Women's 24-cm (U.S. Size 7) Right or Left Prosthetic Foot*, shall be used unless a different size is specified. The foot shall closely approximate the shape, texture, and flexibility of a human foot.

4.2.1 A minimum of six moisture sensors shall be placed at the following locations on the prosthetic foot: instep, big toe, inner and outer ball, and inner and outer heel, as illustrated in Fig. 3.

4.2.2 The moisture sensors shall determine the presence of water. A circuit diagram for a sensor that has proven to be suitable for this application is shown in Fig. 4.

4.3 *Water Tank,* made of stainless steel (or other corrosion-resistant material). The tank shall be large enough so that the

[1] This test method is under the jurisdiction of ASTM Committee F08 on Sports Equipment and Facilitiesand is the direct responsibility of Subcommittee F08.54 on Athletic Footwear.

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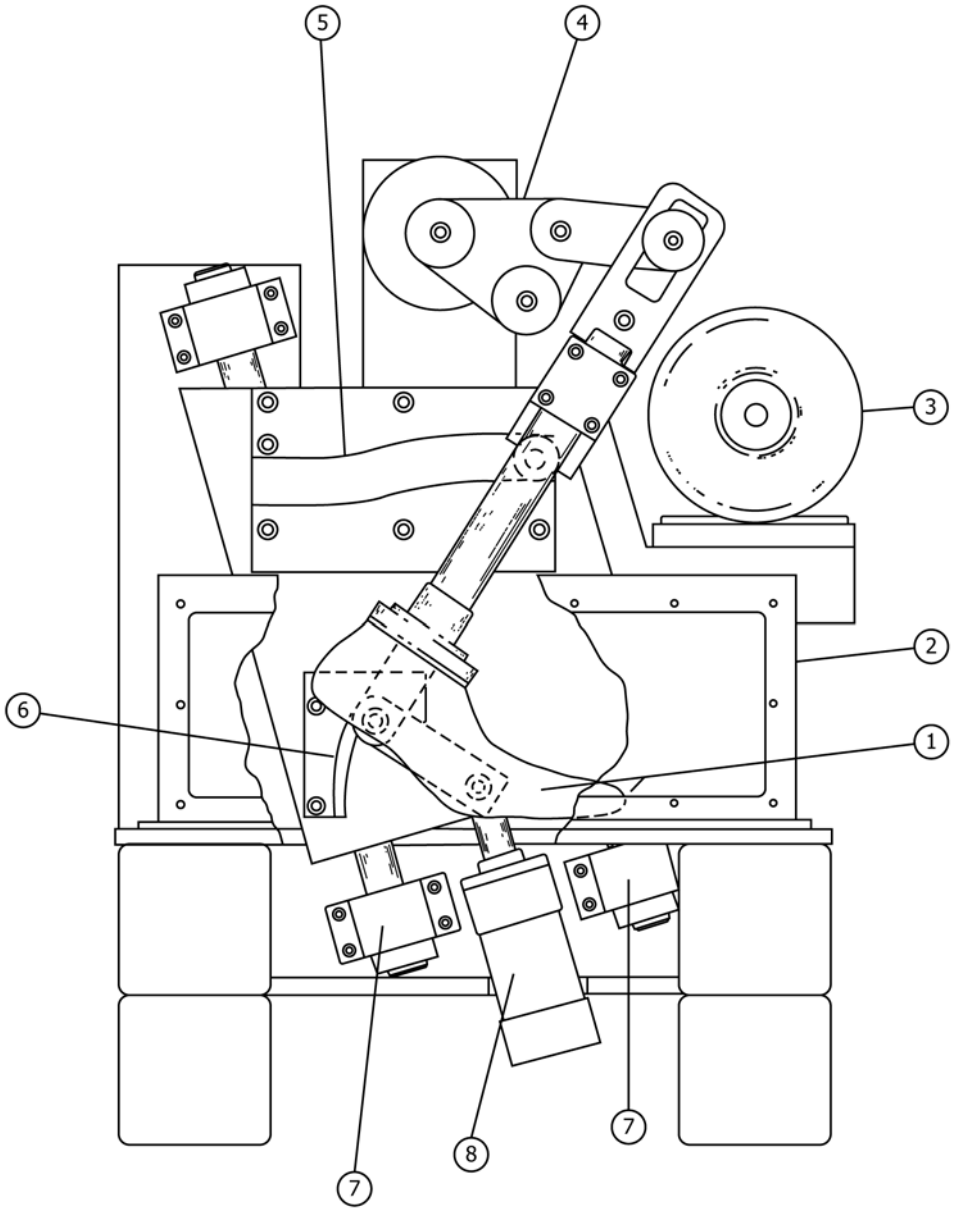
[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from SATRA Footwear Technology Centre, Rockingham Road, Kettering, Northamptonshire, NN16 9JH, United Kingdom.

[4] Available from Footwear Industries of America, 1420 K St. NW, Suite 600, Washington, DC.



(1) Prosthetic foot with moisture sensors
(2) Water tank
(3) Motor with speed control
(4) Mechanism for producing back and forth motion
(5) Cam to control location of knee
(6) Cam to control location of ankle
(7) Slide mechanism
(8) Air cylinder to lower the foot at the beginning of each step and raise it again at the completion of each step

FIG. 1 Footwear Tester

upper portion of a shoe or boot does not come in contact with the tank at any time during the test. The tank should have an opening in the front, that is covered by transparent material, to permit observation of the footwear during the test.

4.4 *Recording Device,* that counts the number of steps (cycles) that the footwear is subjected to, monitors the moisture sensors, and records the number of steps that have been accomplished when the sensors become "wet."

5. Reagents

5.1 *Tap Water,* 20 to 25°C.

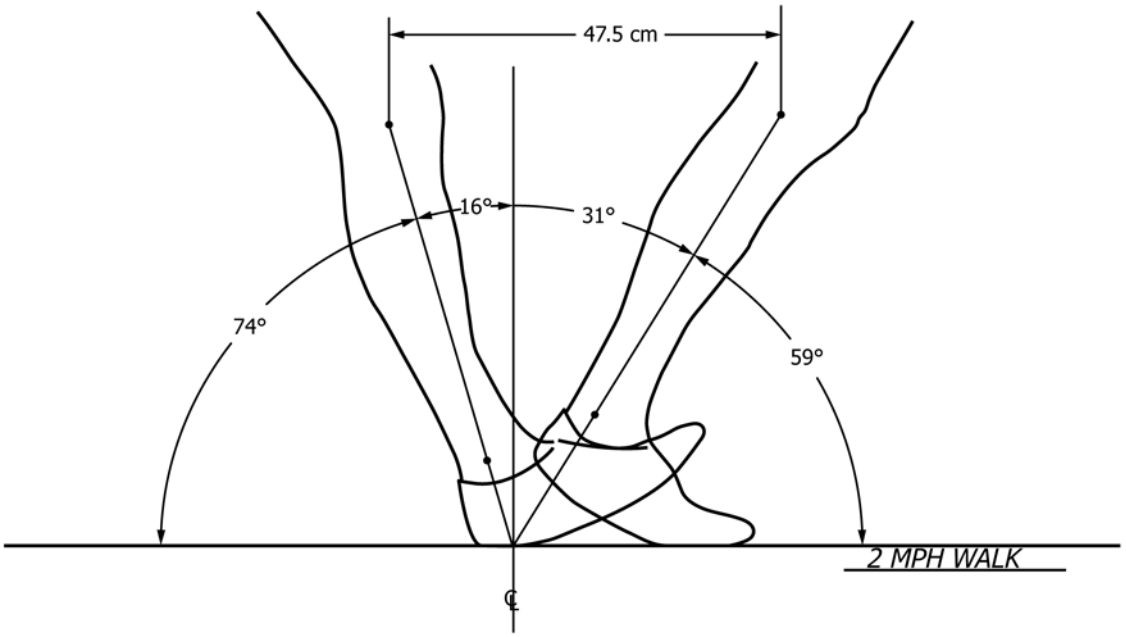


FIG. 2 Typical Ranges of Motion During Ground Contact During Walking at 3.2 kph (2.0 mph)

TABLE 1 Body Masses and Equivalent One Bodyweight Downward Force Levels of 50th Percentile Adults and Children

	Mass, kg	One Bodyweight, newtons
Adult Men	70	687
Adult Women	60	589
Children, Age 10	33	324

6. Test Specimen

6.1 *Footwear,* men's 26 cm (U.S. Size 9) or women's 24 cm (U.S. Size 7) unless a different size is specified.

6.2 *Number of Specimens*—A minimum of three specimens of each model shall be tested.

NOTE 2—Footwear should be thoroughly dry at the beginning of a test. Footwear that has been exposed to water should be dried in a warm, well-ventilated area, away from any direct heat until dry to the touch.

7. Preparation of Apparatus

7.1 The prosthetic foot is removed from the tester and a cotton athletic sock[5] is placed on the foot. The wrinkles and seams of the sock are smoothed, and then the foot is inserted into the footwear. If the footwear has a fastening system, such as laces, it is secured tightly.

NOTE 3—Socks shall be laundered, using nonbiological detergent, and air-dried prior to use.

7.2 *Precautions*—In order to prevent unwanted water penetration, follow these instructions:

7.2.1 *Into the Top of a Shoe Due to Splashing*—Any suitable method may be used to prevent water from entering a shoe over the topline. This includes, but is not limited to, leggings, rubber sheeting, and tape. If necessary, the legging, rubber sheeting, etc., may be glued, using rubber cement or other suitable material, to the shoe. Care should be taken to insure that the glue, legging, etc., does not cover any area that is to be studied for water resistance.

7.3 Install the prosthetic foot and the footwear to be tested on the tester and attach the wires from the moisture sensors to the recording device.

7.4 Place 20 to 25°C water into the tank.

7.5 Water depth shall be minimum of 1.0 cm above the featherline, defined as lower extremity of the upper of the shoe, at the point where it meets the sole or insole.

NOTE 4—The amount of water in the tank may be varied depending upon the type of footwear being tested and the area of the footwear that is to be studied. If the tongue construction is also of interest, the water depth will need to be high enough to insure that the tongue is either under water during a portion of each step, or subjected to splashed water at each step.

8. Procedure

8.1 Operate the tester continuously at a speed of 34 steps/min (equivalent to a 3.2-kph (2-mph) walk) until one of the sensors becomes wet.

8.2 When a sensor becomes wet, stop the test immediately and as quickly as practical, remove and inspect the footwear and attempt to determine the origin of the leak. Record the size and location of the wet area on a report diagram similar to that shown in Fig. 5.

NOTE 5—In some instances, the wet area inside the footwear may be very difficult to define visually. When that is a problem, better contrast between the wet and dry areas may be achieved by adding a water soluble dye to the water in the tank.

8.3 If no leaks occur and the agreed upon number of steps have been completed, stop the tester, and as quickly as practical, remove the footwear and inspect it for evidence of

[5] An 85 % cotton, 15 % nylon crew sock is recommended. If a different type of sock is used, a description of the sock shall be reported.

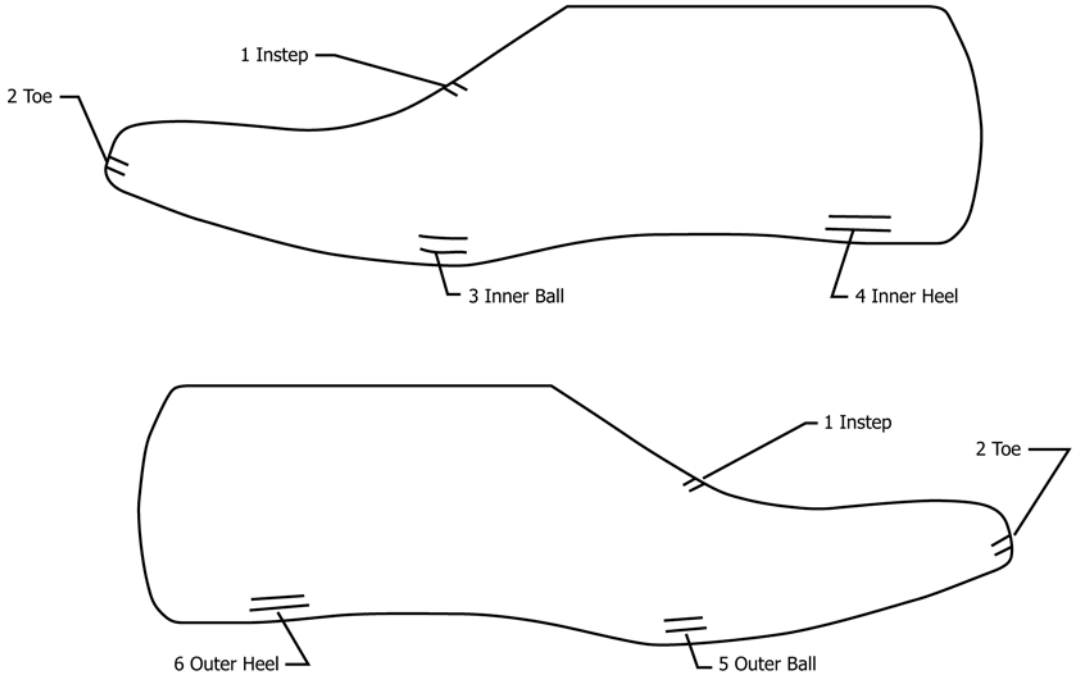


FIG. 3 Approximate Location of Moisture Sensors on Prosthetic Feet

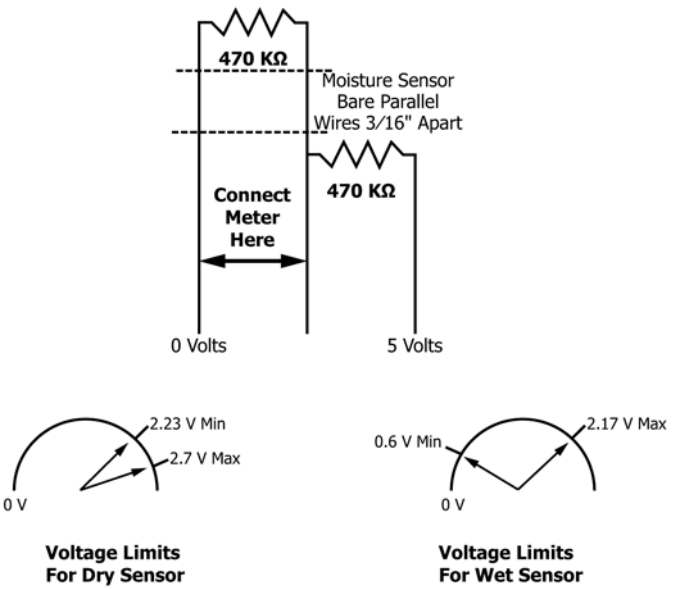


FIG. 4 Moisture Sensor Circuit

water infiltration. If a leak is found, record the size and location of the wet area on a report diagram similar to that shown in Fig. 5. If no evidence of leakage is determined, report that the footwear successfully completed the required number of steps without leaking.

9. Report

9.1 Report the following information:

9.2 *Water Penetration:*

9.2.1 Number of specimens tested,

9.2.2 Description of the footwear tested,

9.2.3 Depth of water in the tank and position reached on the footwear,

9.2.4 Number of steps required to produce water penetration,

9.2.5 Location of leak and size of area affected by the leak,

9.2.6 Additional details, such as precautions taken to ensure that water did not enter the footwear at the topline, and

9.2.7 Any deviations from this test method.

9.3 *Water Resistance*—Report the same information as in 9.2 – 9.2.7, except that if no water penetration occurs, the report shall include the number of steps completed and a statement that no leaks were found (see 8.3).

10. Precision and Bias

10.1 No information is presented here about the precision or bias of this test method for measuring water resistance because the test is nonquantitative.

11. Keywords

11.1 boots; footwear; shoes; sport shoes; walking simulator; water penetration; water resistance

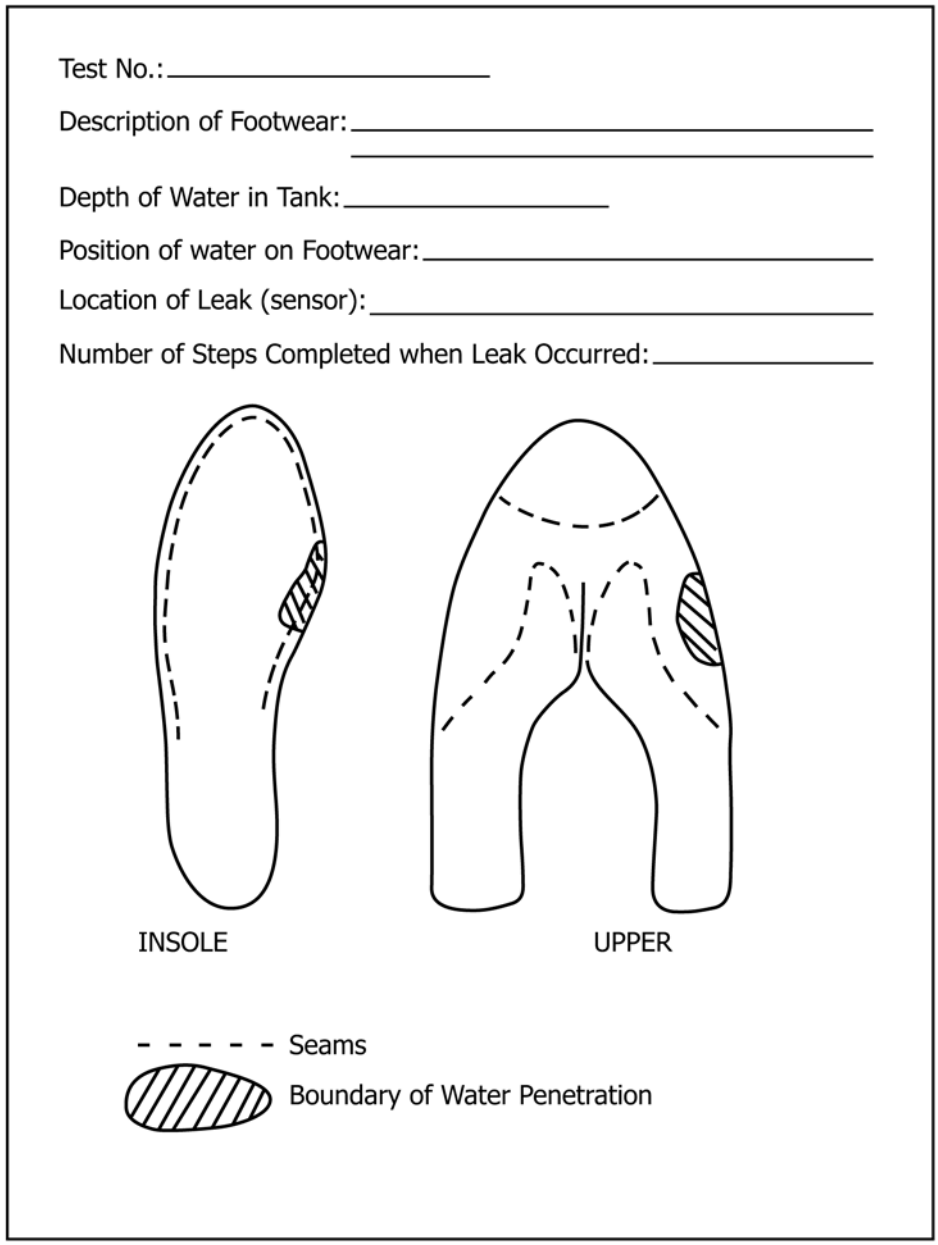


FIG. 5 Typical Report Sheet