

**ITF APPROVED TENNIS BALLS,
CLASSIFIED SURFACES & RECOGNISED COURTS
A GUIDE TO PRODUCTS & TEST METHODS**

ITF APPROVED TENNIS BALLS, CLASSIFIED SURFACES & RECOGNISED COURTS 2019 - a guide to products and test methods

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c/o The Technical Centre
ITF Licensing (UK) Ltd
Bank Lane
Rochampton
London SW15 5XZ
Great Britain

Tel: +44 (0) 20 8878 6464
Email: technical@itftennis.com
Web: www.itftennis.com/technical

What is the International Tennis Federation?

The International Tennis Federation (ITF) is the world-wide governing body of tennis and has the following broad areas of responsibility:

- administering and regulating the game.
- organising international competitions.
- structuring the game.
- developing the game.
- promoting the game.

The ITF Technical Commission is responsible for monitoring developments in equipment technology in order to protect the nature of the game of tennis at all levels. As custodians of the Rules of Tennis, the ITF has the sometimes difficult task of judging whether innovations in tennis equipment may bring about a benefit to those who play, or whether such developments constitute a threat to the nature of the game.

In 1997, the ITF created its own Technical Centre with a laboratory and staff whose task it is to carry out testing and research into all aspects of the game, and to provide support to the ITF Technical Commission and other ITF Committees on decisions relating to technical issues. This facility is now a world-leading tennis research and testing laboratory.

The mission of the ITF Technical Centre is:

To protect the nature of tennis by actively preserving the skills traditionally required to play the game, and, to encourage innovation and improvements which maintain the challenge of the game and make it more exciting to play and watch.

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(i) INTRODUCTION

The Rules of Tennis requires that any ball which is used in any tournament which is played according to the Rules of Tennis, shall be named on the official list of balls which have been tested and approved as conforming to the specifications laid down in the Rules of Tennis and as issued by the International Tennis Federation (ITF).

The Rules of Tennis (see Rule 3 and Appendix I) provide for seven types of ball – a fast-speed ball (Type 1), the standard (Type 2) ball, a slow-speed ball (Type 3) and a High Altitude ball, in addition to Stage 3, 2 and 1 balls. These are designed to have different performance characteristics derived from their dynamic and aerodynamic properties. It should be noted that the Type 3 ball is also permitted and recommended for play at high altitude on any court surface type.

To help determine which ball should be used on which surface, the ITF introduced an official Court Surface Classification Scheme (CSCS) in 2000, which was superseded by the Court Pace Classification Programme (CPCP) from January 2008. This change followed a two-year research project by the ITF Technical Centre that culminated in the development of Court Pace Rating, which provides better agreement between theoretical measurements and player perception of pace than for its predecessor (Surface Pace Rating).

To enable the properties of equipment to be measured in accordance with accepted scientific standards using the SI system, all products are approved or assessed for conformity against the specifications and tolerances given or implied in the SI unit as stated in the current edition of the Rules of Tennis.

Tennis ball approval and the Court Pace Classification Programme have been introduced as part of an initiative to provide further understanding and international standardisation of the equipment used in tennis. They will be of significance to players, National Associations, Referees, tournament organisers and tennis ball manufacturers worldwide.

The ITF Technical Centre commenced testing for ITF Approval for the calendar year 2019 on 1 June 2018. The testing procedure for balls which are to be included on the official list of 2020 ITF Approved balls will commence on 1 June 2019.

The testing of court surface products is undertaken by ITF Accredited Laboratories. ITF Court Pace Classification is valid for a period of three years.

The definitive list of current ITF Approved balls and ITF Classified surface products can be found on the ITF website (www.itftennis.com/technical).

Companies requiring detailed information on the procedures for applying for, and receiving, ITF Approval for tennis balls, ITF Court Pace Classification and ITF Recognition should contact the ITF Technical Centre.

**(ii) THE RULES OF TENNIS – RULE 3 AND APPENDIX I – THE BALL
(Effective 1 January 2019)**

Balls, which are approved for play under the Rules of Tennis, must comply with the specifications in Appendix I.

The International Tennis Federation shall rule on the question of whether any ball or prototype complies with Appendix I or is otherwise approved, or not approved, for play. Such ruling may be taken on its own initiative or upon application by any party with a bona fide interest therein, including any player, equipment manufacturer or National Association or members thereof. Such rulings and applications shall be made in accordance with the applicable Review and Hearing Procedures of the International Tennis Federation (see Appendix XI).

The event organisers must announce in advance of the event:

- a. The number of balls for play (2, 3, 4 or 6).
- b. The ball change policy, if any.

Ball changes, if any, can be made either:

- i. After an agreed odd number of games, in which case, the first ball change in the match shall take place two games earlier than for the rest of the match, to make allowance for the warm-up. A tie-break game counts as one game for the ball change. A ball change shall not take place at the beginning of a tie-break game. In this case, the ball change shall be delayed until the beginning of the second game of the next set; or
- ii. At the beginning of a set

If a ball gets broken during play, the point shall be replayed.

Case 1: If a ball is soft at the end of a point, should the point be replayed?

Decision: If the ball is soft, not broken, the point shall not be replayed.

Note: Any ball to be used in a tournament which is played under the Rules of Tennis must be named on the official ITF list of approved balls issued by the International Tennis Federation.

APPENDIX I – THE BALL

For all measurements in Appendix I, SI units shall take precedence.

- a. The ball shall have a uniform outer surface consisting of a fabric cover, except for the Stage 3 (Red) foam ball. If there are any seams they shall be stitchless.
- b. The ball shall conform to one of the types specified in the table immediately below or in the table under paragraph (d).

	TYPE 1 (FAST)	TYPE 2 (MEDIUM)¹	TYPE 3 (SLOW)²	HIGH ALTITUDE³
MASS (WEIGHT)	56.0-59.4 grams (1.975-2.095 ounces)	56.0-59.4 grams (1.975-2.095 ounces)	56.0-59.4 grams (1.975-2.095 ounces)	56.0-59.4 grams (1.975-2.095 ounces)
SIZE	6.54-6.86 cm (2.57-2.70 inches)	6.54-6.86 cm (2.57-2.70 inches)	7.00-7.30 cm (2.76-2.87 inches)	6.54-6.86 cm (2.57-2.70 inches)
REBOUND	138-151 cm (54-60 inches)	135-147 cm (53-58 inches)	135-147 cm (53-58 inches)	122-135 cm (48-53 inches)
FORWARD DEFORMATION⁴	0.56-0.74 cm (0.220-0.291 inches)	0.56-0.74 cm (0.220-0.291 inches)	0.56-0.74 cm (0.220-0.291 inches)	0.56-0.74 cm (0.220-0.291 inches)
RETURN DEFORMATION⁴	0.74-1.08 cm (0.291-0.425 inches)	0.80-1.08 cm (0.315-0.425 inches)	0.80-1.08 cm (0.315-0.425 inches)	0.80-1.08 cm (0.315-0.425 inches)
COLOUR	White or Yellow	White or Yellow	White or Yellow	White or Yellow

Notes:

¹ This ball type may be pressurised or pressureless. The pressureless ball shall have an internal pressure that is no greater than 7 kPa (1 psi) and may be used for high altitude play above 1,219 m (4,000 feet) above sea level and shall have been acclimatised for 60 days or more at the altitude of the specific tournament.

² This ball type is also recommended for high altitude play on any court surface type above 1,219 m (4,000 feet) above sea level.

³ This ball type is pressurised and is specified for high altitude play above 1,219 m (4,000 feet) above sea level only.

⁴ The deformation shall be the average of a single reading along each of three perpendicular axes. No two individual readings shall differ by more than 0.08 cm (0.031 inches).

c. In addition, all ball types specified under paragraph (b) shall conform to the requirements for durability as shown in the following table:

	MASS (WEIGHT)	REBOUND	FORWARD DEFORMATION	RETURN DEFORMATION
MAXIMUM CHANGE ¹	0.4 grams (0.014 ounces)	4.0 cm (1.6 inches)	0.08 cm (0.031 inches)	0.10 cm (0.039 inches)

Notes:

¹ The largest permissible change in the specified properties resulting from the durability test described in the current edition of *ITF Approved Tennis Balls, Classified Surfaces & Recognised Courts*. The durability test uses laboratory equipment to simulate the effects of nine games of play.

d. Only the ball types specified in the table below can be used in 10 and under tennis competition:

	STAGE 3 (RED) FOAM	STAGE 3 (RED) STANDARD	STAGE 2 (ORANGE) STANDARD	STAGE 1 (GREEN) STANDARD
MASS (WEIGHT)	25.0-43.0 (0.882-1.517 ounces)	36.0-49.0 grams (1.270-1.728 ounces)	36.0-46.9 grams (1.270-1.654 ounces)	47.0-51.5 grams (1.658-1.817 ounces)
SIZE	8.00-9.00 cm (3.15-3.54 inches)	7.00-8.00 cm (2.76-3.15 inches)	6.00-6.86 cm (2.36-2.70 inches)	6.30-6.86 cm (2.48-2.70 inches)
REBOUND	85-105 cm (33-41 inches)	90-105 cm (35-41 inches)	105-120cm (41-47 inches)	120-135 cm (47-53 inches)
FORWARD DEFORMATION¹	-----	-----	1.40-1.65 cm (0.551-0.650 inches)	0.80-1.05 cm (0.315-0.413 inches)
COLOUR²	Any	Red and yellow, or yellow with a red dot	Orange and yellow, or yellow with an orange dot	Yellow with a green dot

Notes:

¹ The deformation shall be the average of a single reading along each of three perpendicular axes. There is no limit on the difference between individual forward deformation readings. There is no specification for return deformation.

² All coloured dots shall be reasonable in size and placement.

e. All tests for rebound, mass, size, deformation and durability shall be made in accordance with the Regulations described in the current edition of *ITF Approved Tennis Balls, Classified Surfaces & Recognised Courts*.

CLASSIFICATION OF COURT PACE

The ITF test method used for determining the pace of a court surface is ITF CS 01/02 (ITF Court Pace Rating) as described in the ITF publication entitled “ITF guide to test methods for tennis court surfaces”.

Court surfaces which have an ITF Court Pace Rating of 0 to 29 shall be classified as being Category 1 (slow pace). Examples of court surface types which conform to this classification will include most clay courts and other types of unbound mineral surface.

Court surfaces which have an ITF Court Pace Rating of 30 to 34 shall be classified as being Category 2 (medium-slow pace), while court surfaces with an ITF Court Pace Rating of 35 to 39 shall be classified as being Category 3 (medium pace). Examples of court surface types which conform to this classification will include most acrylic coated surfaces plus some carpet surfaces.

Court surfaces with an ITF Court Pace Rating of 40 to 44 shall be classified as being Category 4 (medium-fast pace), while court surfaces which have an ITF Court Pace Rating of 45 or more shall be classified as being Category 5 (fast pace). Examples of court surface types which conform to this classification will include most natural grass, artificial grass and some carpet surfaces.

Case 1: Which ball type should be used on which court surface?

Decision: 3 different types of balls are approved for play under the Rules of Tennis, however:

- a. Ball Type 1 (fast speed) is intended for play on slow pace court surfaces*
- b. Ball Type 2 (medium speed) is intended for play on medium-slow, medium and medium-fast pace court surfaces*
- c. Ball Type 3 (slow speed) is intended for play on fast pace court surfaces*

Note:

In addition to the ball types specified under paragraph (b) above, the Stage 1 (Green) ball may be used for all levels of competitive play except for world ranking professional tennis events, Davis Cup and Fed Cup, Junior Tournaments and Team events sanctioned by the ITF and affiliated Regional Associations, ITF Senior Circuit and Team events and ITF Wheelchair Circuit and Team events. Each National Association shall have the right to decide which national competitive events should use the Stage 1 (Green) ball.

(iii) ISO 9001:2015

All testing, administration and calibration procedures adopted by the ITF Technical Centre in testing tennis balls for ITF Approval, surface products for ITF Classification, and courts for ITF Recognition are carried out and managed according to ISO 9001:2015

(iv) FUTURE DEVELOPMENT OF TESTING METHODS, TENNIS BALL SPECIFICATIONS AND COURT PACE RATING VALUES

The ITF reserves the right to amend and update the information given in this document without prior notice. As a general rule, amendments will be made only after consultation with interested parties.

PART A – THE BALL

1. REGULATIONS FOR THE TESTING OF TENNIS BALLS FOR ITF APPROVAL

The properties of tennis balls are specified by the International Tennis Federation to generate uniformity, and consistency in performance. Special testing facilities and apparatus are necessary to accurately measure these properties, and this section details the required test conditions and procedures.

The following notes are provided as additional information for those involved in the testing or evaluation of tennis balls and should be read in conjunction with the specification for a tennis ball, as described in Rule 3 and Appendix I of the Rules of Tennis.

1.1 General Considerations

With the exception of Stage 3 moulded foam and cut foam types, a tennis ball consists of a hollow rubber core (which may or may not be pressurised) covered by a textile material composed of wool, nylon and cotton. Because the properties of the rubber core and its internal gas are affected by temperature, the properties of the cover by atmospheric moisture, and the effective internal pressure by the external atmospheric pressure, it is important that ball testing is carried out in a controlled environment where at least temperature and humidity are standardised. While it is not practical to control atmospheric pressure, it is desirable that any testing station should be at or near sea level so that test data are comparable. In any case, atmospheric pressure should always be recorded when ball tests are made.

The following conditions are specified for testing by the ITF (the “**Controlled Environment**”):

Temperature	$20 \pm 2^{\circ}\text{C}$ (68°F)
Relative humidity	$60 \pm 5\%$
Atmospheric pressure	$102 \pm 3 \text{ kPa}$ (30 inches Hg)

Other Controlled Environment standards may be fixed for localities where one or more of the average temperature, humidity and average barometric pressure at which the game is being played differ materially from 20° Celsius (68° Fahrenheit), 60% relative humidity and 102 kPa (30 inches Hg) respectively.

Applications for such adjusted standards may be made by any National Association to the ITF and, if approved, shall be adopted for such localities.

1.2 Environmental Conditions

To meet the Controlled Environment requirements noted above, a well-insulated room with double-glazed windows not exposed to direct sunshine, and a double-door 'air-lock' arrangement to reduce air leakage on entry and exit, are recommended.

Control of temperature and humidity should be provided by a temperature and humidity control unit of an appropriate specification with regard to thermal capacity and control accuracy. Such a conditioner normally consists of two component parts: an internal fan unit and an external condenser unit with connecting piping.

The specification of this conditioning equipment is primarily related to removing excess heat and moisture generated within the environment by electrical equipment and the bodies of the technicians working there. Such equipment must be capable of controlling the testing environment within the tolerances set down in Section 1.1.

As well as controlling the environment, the conditioning equipment should also be independently monitored, and so temperature and humidity recorders together with a barometer are necessary. A permanent record of environmental conditions during conditioning and testing should be kept.

Balls selected for testing should be stored under such controlled conditions and exposed to circulating air for 'conditioning' for a minimum of 24 hours prior to testing.

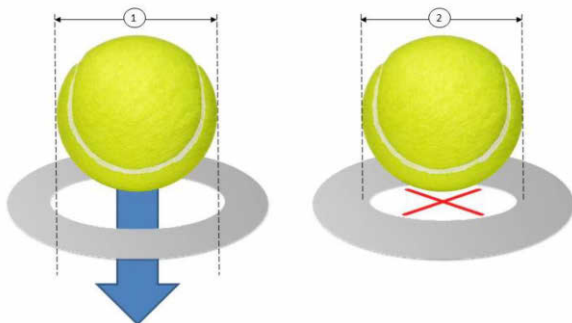
1.3 Laboratory and Test Equipment

Mass – Test Method ITF TB 01/01: An electronic laboratory balance measuring in grams to at least two decimal places, to a capacity of 100 grams.

Size – Test Method ITF TB 02/01: Two ring gauges with diameters of the upper and lower limits for the respective ball. In all tests for diameter, the ring gauge used shall consist of a metal plate (preferably non-corrosive) of uniform thickness of 0.318 cm (0.125 inches). In the case of Type 1 (fast speed) and Type 2 (medium speed) balls, plates with circular openings measuring 6.54 cm (2.57 inches) and 6.86 cm (2.70 inches) in diameter respectively shall be used. In the case of Type 3 (slow speed) balls, plates with circular openings measuring 7.00 cm (2.76 inches) and 7.30 cm (2.87 inches) in diameter respectively shall be used. In the case of Stage 1 balls, plates with circular openings measuring 6.30 cm (2.48 inches) and 6.86 cm (2.70 inches) in diameter respectively shall be used. The inner surface of the gauge shall have a convex profile with a radius of 0.160 cm (0.063 inches). See Figure 1.

Deformation – Test Method ITF TB 03/01: A modified Stevens Machine (i.e. one which measures forward deformation and return deformation) capable of applying a force along a diameter of a ball, and measuring the resulting deformation.

Prior to deformation testing, the ball must be pre-compressed through a distance of 2.54 cm (1.0 inches) three times on each of three perpendicular axes in order to remove any 'set' in the ball. One pre-compression should occur on each axis in succession, until nine pre-compressions in all are completed. This is carried out on a pre-compression jig. See Figure 2.



- (1) A ball must pass through a ring gauge (under its own weight) with an internal diameter of:

Ball Type 1 & Type 2: 6.86 cm (2.70 inches)

Ball Type 3: 7.30 cm (2.87 inches)

Stage 1 (Green) ball: 6.86 cm (2.70 inches).

- (2) A ball must not pass through a ring gauge (under its own weight) with an internal diameter of:

Ball Type 1 & Type 2: 6.54 cm (2.57 inches)

Ball Type 3: 7.00 cm (2.76 inches)

Stage 1 (Green) ball: 6.30 cm (2.48 inches).

Figure 1. Size – Test Method ITF TB 02/01.

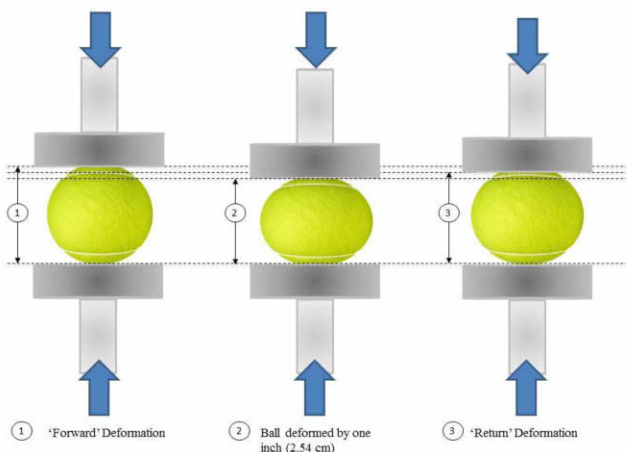


Figure 2. Pre-Compression – Test Method ITF TB 03/01.

An approved machine shall comprise the following: A first rigid platen connected to a force-measuring device and a second identical and parallel platen which can move axially with respect to the first platen, such that when a ball is placed between them it can be compressed along its diameter between the platens and measurement taken of its deformation at a predetermined force. The platen design shall be as shown in Figure 3.

Note: The Stevens machine is deemed to be compliant with the above.

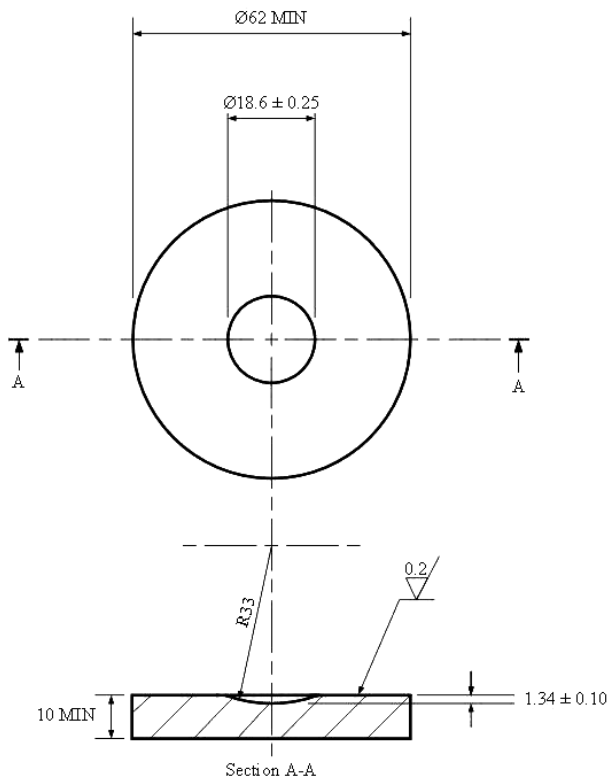


Figure 3. Deformation – Test Method ITF TB 03/01. Specification of platen design (to be used for both platens). All dimensions are given in millimetres.

Rebound – Test Method ITF TB 04/01: The ball is dropped from a height of $254 \pm 0.3 \text{ cm}$ ($100 \pm 0.1 \text{ inches}$) (measured from the bottom of the ball) onto a smooth, rigid and horizontal block of high mass and the rebound height is measured (again to the bottom of the ball). See Figure 4.

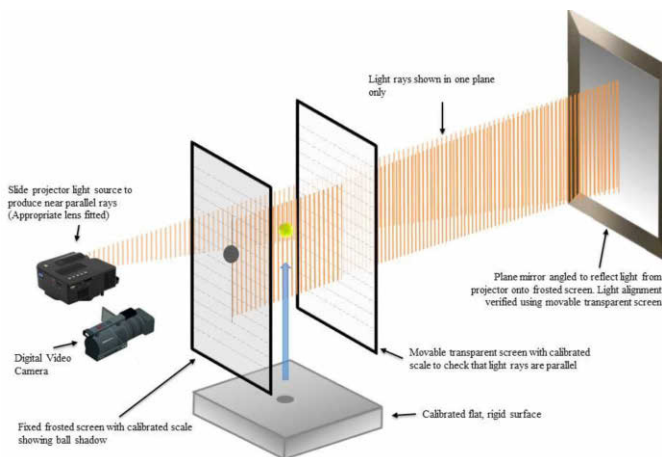


Figure 4. Rebound – Test Method ITF TB 04/01.

To ensure sufficient accuracy of the rebound measurement, the following method is recommended. A shadow of the ball produced by a parallel and horizontal beam of light is cast onto a vertical frosted screen incorporating a graduated calibrated scale. Images of the shadow are captured by a video camera, and the trajectory of the ball analysed such that its highest point with reference to the calibrated scale can be identified.

Durability – Test Method ITF TB 05/01: The ball is projected such that it impacts a smooth, rigid surface mounted at $90 \pm 10^\circ$ to its trajectory at 40 ± 3 m/s with ≤ 3 rev/s spin. This procedure shall be repeated until the ball has undergone 20 impacts. The ball shall then be placed in a felt-wearing device, with a second ball, for a period of 2 minutes. This wearing procedure (the “wearing regime”) may be performed outside of the Controlled Environment. Following this procedure, the ball is conditioned in the Controlled Environment for a minimum of 24 hours and then retested for rebound, size, mass and deformation in accordance with the procedures described herein.

In all tests for durability, the felt-wearing device shall consist of a box lined with medium grade emery paper (which shall be obtained from the ITF), and inclined at 23° to the horizontal, with three rotating wooden spigots at the lowest point. The internal dimensions of the box shall measure 15 ± 1 cm by 15 ± 1 cm and 69 ± 1 cm in length. Each spigot shall measure 19 ± 1 cm in length and 2.0 cm in diameter, and shall be rounded at both ends with a radius of 1.0 cm. The angle between the spigots, measured about the centreline of the axle, shall be 60° . The distance between the centrelines of adjacent spigots shall measure 4.5 cm. Each spigot shall protrude 4.0 cm into the box, when parallel to the bottom end face of the box, and the centreline of the spigot shall measure 3.0 cm to the aforementioned face when in this position. The angular velocity of the spigots shall be 500 ± 50 rpm. See Figure 5.

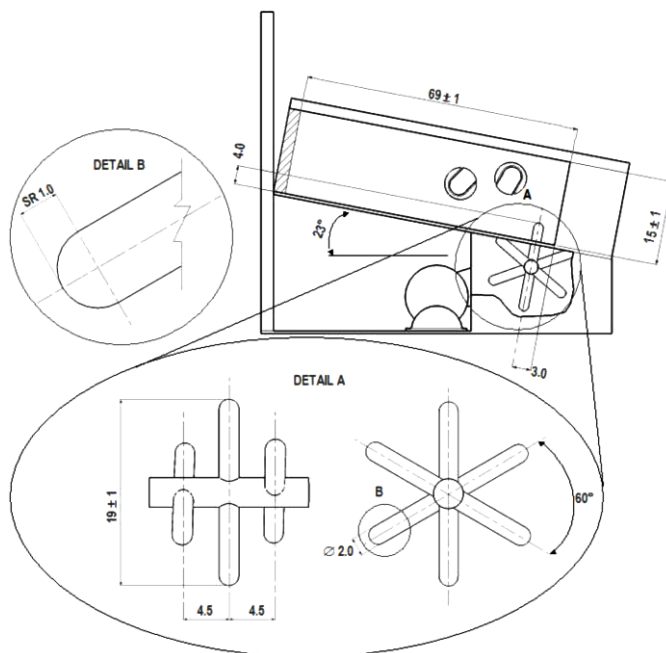


Figure 5. Durability – Felt wearing device for test method ITF TB 05/01.
All dimensions are given in centimetres.

Size (Durability) – Test Method ITF TB 06/01: A drop gauge measuring in centimetres to at least three decimal places, to a capacity of 10 cm. The contact foot of the drop gauge shall be a circular metal disc of diameter 1.2 ± 0.1 cm.

1.4 Test Procedure

From the 72 balls submitted for approval (36 balls for Stage 2 and Stage 3), the ITF randomly selects 24 for testing (12 balls for Stage 2 and Stage 3). The ball containers are opened and the balls are then stored on racks in the Controlled Environment for a minimum of 24 hours prior to testing. Each ball should be individually marked (preferably with a permanent marker) so that test results can be assigned to a particular ball.

Following visual inspection, the test procedure should be carried out on each ball in the following sequence:

- i. **Pre-compression.** Apply to each of the three axes in succession, as described in Section 1.3. All subsequent tests are to be completed within two hours of pre-compression.

ii. **Mass.** Record the mass displayed in grams and round to one decimal place.

iii. **Size.** Use ring gauges across at least three mutually perpendicular diameters. For all ball types, the ball shall not drop through the smaller opening by its own weight in any orientation and shall drop through the larger opening by its own weight in all orientations. Care should be taken to ensure that the ball relies only upon its own weight to pass through a ring. Record Pass/Fail.

Size (Durability). The ball shall rest under its own weight directly below the contact foot of the drop gauge. A vertical load of approximately 0.5 N is applied to the ball by the contact foot. The reading is recorded 5 seconds after the load is applied. The ball diameter shall be the average of a single reading along each of three perpendicular axes, reported in centimetres to two decimal places.

The 'Go/No-Go' method (described above) serves as the pass/fail criterion for absolute size.

iv. **Deformation.** Test once on each axis and record the results. Report the mean value, and the maximum difference between the three readings¹, for each ball (see also Section 1.3). The test measures the deformation of a ball under a load of 80.07 ± 0.5 N (18.00 ± 0.1 lbf) after an initial 'contact' load, of 15.57 ± 0.5 N (3.50 ± 0.1 lbf), has been applied to compress the fabric cover material. See Figure 6. The 'deformation' is measured in two senses:

- a. When the load is first applied (forward deformation).
- b. Under the action of the load prior to it being removed and after the ball has been compressed further through a total distance of 2.54 cm (1.0 inches) (return deformation).¹

The ball is placed in position so that neither platen of the machine is in contact with the cover seam. A contact load of 15.57 ± 0.5 N (3.50 ± 0.1 lbf) is applied and the displacement of the platens under this load becomes the datum for the deformation readings. A constant platen speed of 200 mm/min (7.87 inches/min) is then applied up to an additional load of 80.07 ± 0.5 N (18.00 ± 0.1 lbf). The total test load is therefore 95.64 ± 0.5 N (21.50 ± 0.1 lbf). The total test load is held for 5 seconds before the forward deformation reading is recorded. The constant platen speed is then resumed to produce a deformation of 2.54 cm (1.0 inch), and then immediately reversed until it reaches the test load (95.64 ± 0.5 N). The test load is held for 10 seconds before the return deformation is recorded. The load is then completely removed at the constant platen speed. This procedure is repeated on each ball across the two diameters at right angles to the initial position and to each other.

¹ There is no specification for the maximum difference between the three readings for forward deformation for Stage 1 balls.

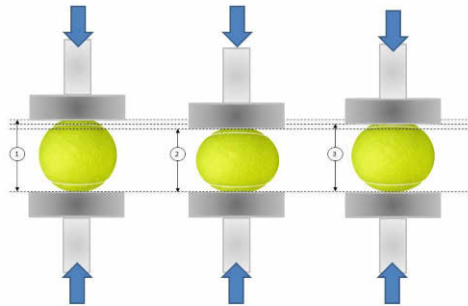


Figure 6. Deformation – Test Method ITF TB 03/01.

Automated compression machine

The automated compression machine (pictured below) has been developed by the ITF as an alternative to the Stevens machine for testing tennis ball deformation.

The computer-controlled machine replicates the operation of the Stevens machine, but provides the following improvements over the Stevens machine:

- a. Elimination of operator error in speed and timing of testing.
- b. Reduction of backlash (unmeasured movements due to machining tolerance and wear).
- c. Graphical display of useful comparative information such as hysteresis losses.
- d. Carousel feed allowing up to 12 balls to be tested in three axes without operator assistance.
- e. The machine can also be used to pre-compress balls according to the Rules of Tennis.



All of these advantages give the automated machine more functionality, accuracy and better reproducibility of results than the Stevens machine. For further information on automated compression machines, contact the ITF Technical Centre.

- v. **Rebound.** Record four valid measurements per ball (disregarding bounces that deviate significantly from vertical) and report mean rebound height in centimetres to one decimal place.
- vi. **Internal pressure.**
 - a. Packaging. All sealed packaging is measured using a standard pressure gauge with needle attachment and rubber seal.
 - b. Ball. Four balls are tested. Measurements are taken using a standard pressure gauge with needle attachment.

Note: This test does not apply to Stage 2 and Stage 3 balls.
- vii. **Durability.** Select six balls at random from the sample that was tested for approval. Apply the wearing regime described in Section 1.3. Visually inspect the balls for signs of detachment of the fabric cover, and cracks or ruptures. Record the results for mass, size, deformation and rebound, as described in paragraphs (i) to (v) above. Report the change in the specified properties from the original results for each test.

Note: This test does not apply to Stage 1, Stage 2 and Stage 3 balls.

1.5 Calibration

The apparatus used for the various tests must be regularly checked for accuracy of calibration as follows:

Size. The ring gauges should be checked for accuracy against a known traceable reference every two years. The tolerance on ring gauge diameter should be ± 0.0064 cm (0.0025 inches).

Size (Durability). The drop gauge should be checked monthly with calibrated slip gauges. The accuracy of the drop gauge should be ± 0.002 cm.

Mass. The weighing scales should be checked with calibration weights monthly. The accuracy of the scales should be ± 0.01 g.

Rebound. Where the 'video' system is used for measuring rebound, the horizontal alignment of the light beam must be checked at the beginning and end of each test sequence. The accuracy of drop height and the frosted and transparent scales should be checked monthly. The accuracy of the drop height and both scales should be ± 0.3 cm (0.1 inches).

Pressure. Pressure gauges should be checked for accuracy annually. The accuracy of the gauges should be ± 0.3 kPa (0.04 psi).

Deformation. The Stevens machine should be checked daily for beam balance with the contact weight removed. It should be checked also for accuracy of platen displacement twice per year using 60 mm slip gauges. The accuracy of platen displacement should be

± 0.008 cm. The automated compression machine, including the load cell and platen displacement, should be checked for accuracy against a known traceable reference annually. The accuracy of the load cell should be $\pm 0.2\%$ over the full scale of its operation (0-1 kN) and the platen displacement should be ± 0.008 cm.

Durability. The velocity of ball projection should be checked monthly. The spin rate of ball projection should be checked every two years. The angular velocity and size of the spigots in the felt-wearing device should be checked annually. Tolerances are provided in the Durability Test Method above. The emery paper should be replaced using the following protocol (refer to Figure 7):

- After 16 hours of testing, replace only the pieces labelled number 1 using new pieces of evenly-cut medium grade emery paper (obtained from the ITF) and adhesive spray or adhesive tape applied to the reverse. Ensure that there is no overlap or gap between adjacent pieces.
- After a further 16 hours of testing, replace only the pieces labelled number 2 as described above.
- After a further 16 hours of testing, replace only the pieces labelled number 3 as described above.
- After a further 16 hours of testing, replace only the pieces labelled number 4 as described above.
- Return to step (a).

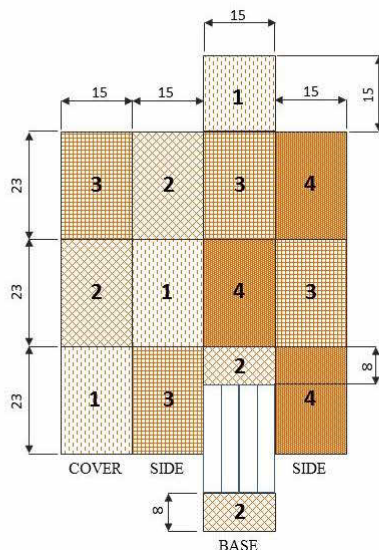


Figure 7. Schematic diagram of the locations of emery paper in the felt-wearing device (net drawing from above). All dimensions are given in centimetres.

1.6 Conditions for ITF Approval

All manufacturers that wish their ball brand(s) to be considered for inclusion on the annual list of ITF Approved tennis balls must submit a sample of such brand(s) for testing by the ITF in the manner described above. The sample of balls submitted must conform to the Rules of Tennis in all respects in order for ITF Approval to be granted. The markings on the ball and its packaging must be appropriate for tennis. Further details on the eligibility of ball markings and packaging can be found in the current ITF Ball Approval procedures, available to download from www.itftennis.com/technical.

A ball which is granted ITF Approval is approved by the ITF only on the basis that it has been found to conform to the current Rules of Tennis and is therefore considered suitable for use in tournaments played according to the Rules of Tennis. ITF Approval does not imply any other form of approval.

The ITF reserves the right to withdraw ITF Approval from any tennis ball brand(s) at any time if it finds that balls are substantially different from the sample(s) submitted for approval or, in the opinion of the ITF Technical Commission, such balls are not designed to meet the specification laid down in the Rules of Tennis, or if the approved balls otherwise fail to meet a reasonable quality standard.

1.7 Market and tournament testing

The ITF has additional specific requirements for tennis balls which have been granted ITF Approval, to ensure that such balls continue to meet the standards laid down in the Rules of Tennis. Such balls may be obtained and tested from any source world-wide at the sole discretion of the ITF. ITF Approved balls are required to meet certain criteria, as described below, in order to retain ITF Approved status.

The minimum sample size for balls tested under this procedure is 12. A ball which fails to conform to one or more of the specifications laid down in the Rules of Tennis will be counted as a single failure.

The criteria by which samples of balls will be assessed are as follows:

No. of balls in sample	No. of balls failing to conform	Action
12	0-1 2-3 4 +	None Letter of warning 1 point towards removal of ITF Approval
24	0-2 3-7 8 +	None Letter of warning 2 points towards removal of ITF Approval

The above criteria are based on the normal distribution curve with action being taken in the form of either a warning letter to the manufacturer/distributor, or points towards removal of ITF Approval at ± 1 and ± 2 standard deviations from the mean respectively. Criteria for other sample sizes are calculated accordingly.

- a. If the number of failures in a single brand in any samples totalling at least 72 results in the accrual of six points towards removal of ITF Approval during a rolling 12-month period, the manufacturer will receive a 'yellow card'. The date of notification of the 'yellow card' (which will be the date of the test in which the sixth point was accrued) will trigger a 12-month notice period (the "Notice Period") to enable the manufacturer to address the cause of the failures. The ITF will endeavour to continue to market-test balls during the Notice Period, and notify the manufacturer of failures/passes in accordance with the above criteria. If, in the 12 months following the end of the Notice Period, the brand in question fails Market Testing, i.e. obtains a second 'yellow card', the manufacturer will receive a 'red card', at which time ITF Approval will be removed with immediate effect.
- b. Removal of ITF Approval will remain in force for 12 months (the "Removal Period"), from the date of the 'red card'. Manufacturers will be permitted to submit balls for testing for ITF Approval prior to the end of the Removal Period, but any new approval will not begin until the Removal Period has expired.

Removal of ITF Approval is at all times at the sole discretion of the ITF. The ITF reserves the right to withdraw ITF Approval from any ball at any time.

2. 2019 ITF APPROVED TENNIS BALLS

The list of ITF Approved balls for use in 2019 is published on the ITF website (www.itftennis.com/technical). As additional balls are added, the website is updated.

PART B – ITF GUIDE TO TEST METHODS FOR TENNIS COURT SURFACES

1. INTRODUCTION

Tennis is played on a variety of surfaces, more so perhaps than any other sport. The properties of each surface influence the style of play and affect the quality of performance.

The following notes seek to outline and quantify the key properties that affect play, with the aims of:

- Establishing a minimum level of quality and encouraging high-quality workmanship.
- Improving standards, based on what is currently achievable by experienced contractors using quality materials and conventional methods at reasonable cost.
- Enabling comparisons between courts, giving court constructors, suppliers and end-users a common language to describe different products.
- Protecting contractors against unreasonable demands.

This section is intended to provide a guide to tests suitable for tennis courts for end-users, tournament organisers and court proprietors, in addition to acting as a manual for test houses, suppliers and constructors. The methods described herein will be particularly applicable to surface testing in:

- Venues for elite-level tennis tournaments, such as the Davis Cup.
- National/regional tennis centres.
- Other tennis facilities where the standard of play demands the specification of precise playing characteristics.
- Research and development laboratories.

The ITF has identified ‘definitive’ and ‘predictive’ methods for testing the key properties of a surface. Definitive methods are recommended for laboratory testing and on-site testing of courts for professional competition. Predictive methods provide a more economical means of on-site testing.

IMPORTANT NOTE: Whilst these test methods are recommended by the ITF, they are not mandatory.

This section is a revision of *An Initial ITF Study on Performance Standards for Tennis Court Surfaces*, published in June 1997. Further developments are anticipated, and consequently this section is supported by a web-based resource to communicate such changes. The latest version can be found at: www.itftennis.com/technical.

The properties of court surfaces are known to change, due to factors such as ambient conditions, use and maintenance. Unless otherwise stated, this section refers to court surfaces which have been given sufficient time to stabilise (as advised by the contractor or supplier).

Disclaimer: This section does not intend to, nor does it in fact, establish any binding rules or regulations relating to acceptable standards for tennis courts. This section is not part of the Rules of Tennis. The ITF cannot be held responsible for, and accepts no liability for, the failure of any product or service manufactured, produced or provided according to the information given in this section or for any acts or omissions made in reliance upon it or in connection with it. In relation to the contents of this section and/or any act or omission made in reliance upon it or in connection with it, the ITF accepts no liability for any loss of income or revenue, loss of business, loss of profits or contracts, loss of anticipated savings, or for any indirect or consequential loss or damage of any kind however arising and whether caused by tort (including negligence) breach of contract or otherwise, even if foreseeable. Furthermore, the ITF cannot be held responsible for, and accepts no liability for, any injury sustained during the testing of surfaces using the methods described herein, or for any injury sustained while playing on a court that meets any guideline or recommendation in this section.

2. KEY PROPERTIES

The key properties of a court surface are as follows:

Friction: The resistance to relative movement between a court surface and an object in contact with that surface. The coefficient of friction (COF) is the ratio of the horizontal and the vertical components of force between the ball and the surface. A rougher surface has a greater COF, causing a greater reduction in the horizontal velocity and the surface to play 'slower'.

Energy restitution: The energy returned by the surface (and ball) following impact. A decrease in energy return is manifested as a reduction in vertical velocity of the ball after impact. The coefficient of restitution (COR) is the ratio of the vertical velocity of the ball after the bounce to that before impact. A surface that yields a higher COR is typically perceived to play slower, because the player has more time to reach the ball.

Topography and dimensions: The geometric regularity of the surface (evenness); the gradient (slope) and planarity designed to assist drainage; and the relative locations of court markings (dimensions).

Consistency: The uniformity of surface properties over the entire playing area and their stability with time, use and maintenance.

3. GENERAL CONSIDERATIONS

It is preferred that surfaces are tested *in situ*, although it is accepted that the testing of samples in a laboratory may be more practical (and effective) in some cases. The test method for court pace (ITF CS 01/02) is applicable to both laboratory and on-site testing.

On-site testing

Following installation, on-site tests should not be carried out until the court surface has been given sufficient time to stabilise. Typically, the playing surface of an acrylic court requires a week to stabilise, whereas clay or artificial grass may need several months. Factors that affect stabilisation time include: surface type, site conditions, e.g. climate and shade, usage and maintenance. The stabilisation time should be agreed with the contractor in advance of testing. Prior to testing, the court shall be prepared using the manufacturer's, supplier's and/or contractor's procedures.

Testing commences with a visual inspection of the court. At a minimum, the court should have a uniform appearance, with no gaps between joins or cracks, and straight court markings.

During testing, the prevailing environmental conditions should be recorded, including:

- Maximum and minimum temperature of the air, surface and test balls.
- Maximum and minimum relative humidity.
- Maximum and minimum atmospheric pressure.
- Condition of the surface, i.e. dry, damp, etc.

Unless the surface is designed to be damp/wet when in its optimum condition, tests should be made when the surface is dry. To minimise the effects of changes in ambient conditions, the test should be completed as soon as is reasonably possible. Tests for court pace (ITF CS 01/02) should not take place if the average temperature of the test balls cannot be maintained within the range 10-30°C.

Tests conducted at above 1,219 m (4,000 feet) must use balls permitted for play at high altitude as defined in the Rules of Tennis.

Tests for court pace (ITF CS 01/02) and ball rebound should be carried out in at least four different locations. Recommended locations – representative of high, medium and low usage areas, and court markings – are shown in Figure 1 (the arrowheads indicate the location and direction of testing).

Note: In addition to the recommended locations, any area of particular concern, such as joins between modular systems, should be tested.

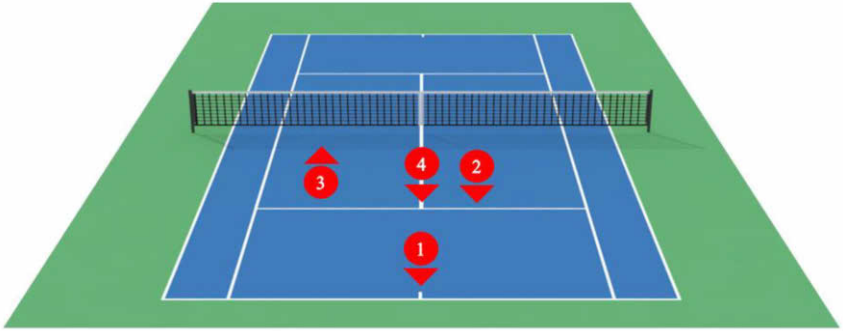


Figure 1. Recommended locations (and test directions) for on-site testing.

Laboratory testing

For tests in the laboratory, the test specimen must be conditioned at the test temperature ($23 \pm 2^\circ\text{C}$) for a minimum of 3 hours.

Test specimens for laboratory testing should be flat and have minimum dimensions of $0.5\text{ m} \times 0.5\text{ m}$, and include any relevant supporting layers or aggregate used in construction.

Note: Loose-laid specimens should be anchored at the edges.

Test balls

A high-specification ball is required for court testing to reduce the effect of ball properties on the measurement of surface characteristics (see Table 1).

Type of ball	Pressurised
Mass	$57.6 \pm 0.3\text{ g}$
Diameter	$6.60 \pm 0.05\text{ cm}$ ($2.598 \pm 0.020\text{ inches}$)
Forward deformation	$0.64 \pm 0.04\text{ cm}$ ($0.252 \pm 0.016\text{ inches}$)
Return deformation	$0.94 \pm 0.14\text{ cm}$ ($0.370 \pm 0.055\text{ inches}$)
Rebound	$141 \pm 1\text{ cm}$ ($55.5 \pm 0.4\text{ inches}$)
Woven cloth	$55 \pm 5\%$ wool, $45 \pm 5\%$ nylon

Table 1. Ball specification for surface testing.

For all tests, balls should be kept pressurised in their cans at $23 \pm 2^{\circ}\text{C}$ prior to testing, and pre-compressed before use. Pre-compression is intended to remove temporary ‘set’ in the ball, which may occur during prolonged storage. Pre-compression consists of compressing the ball by approximately 2.5 cm on each of three diameters at right angles to one another in succession; this routine is carried out three times (nine compressions in all)¹.

Balls should not be subjected to more than 12 impacts each, excluding any pre-compression impacts, to ensure that their original properties are retained throughout testing.

Average ball temperature should be recorded to the nearest degree Celsius for each test location/sample. An infrared thermometer, calibrated to $\pm 1^{\circ}\text{C}$, is recommended for this purpose.

Test reports

Each test performed requires a report to document the results and conditions. The test report should contain all relevant information, including:

- Reference to the ITF test method and code.
- Identification, and detailed description, of the surface composition, including supporting layers, and its condition.
- Information on the test environment: temperature; humidity; atmospheric pressure; altitude; venue.
- Statement of the ball brand name and country of manufacture.
- All results.
- Overall result, typically the average and variation of the measurements (for comparison against the category or recommendation).

¹ Firing the ball three times at an oblique angle onto a smooth, rigid surface using a ball projection device at 30 ± 2 m/s is an optional means of applying pre-compression.

4. COURT PACE (ITF CS 01/02)

The ITF Court Pace Rating (CPR) measures the effect of ball-surface interaction. This concept includes: friction, which primarily determines the reduction in the horizontal component of post-impact ball velocity, and vertical restitution, which determines the time between successive bounces.

CPR is derived from a theoretical model of ball/surface impact that assumes that the ball and surface are rigid during the impact and that the ball slides throughout its contact with the surface. These assumptions necessitate that the ball impacts the surface with negligible spin and at a particular speed and angle.

Apparatus

Test apparatus consists of:

- A means of projecting a ball at the specified speed and angle onto the surface with spin of no more than 3 rev/s¹, such as a compressed air-powered ball cannon.
- A means of monitoring the trajectory of the ball before and after impact such that its horizontal and vertical speeds can be measured with a maximum uncertainty of ± 0.05 m/s (see Figure 2).
- A minimum of three high-specification balls (see Table 1).

Note: Angle of travel can be deduced from the vertical and horizontal speeds.

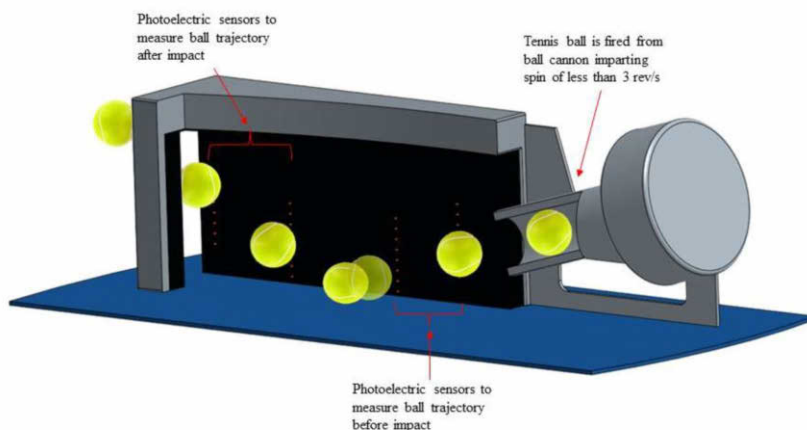


Figure 2. Test apparatus for measuring court pace.

¹ The spin rate of the ball can be checked using a high-speed video camera or stroboscope photography.

Calibration of apparatus

The reference test devices are those belonging to the ITF, and all other devices are calibrated with respect to them. Calibration of test devices is achieved using standard surfaces every two years.

Test procedure

1. Adjust the ball-projecting apparatus to deliver the ball at an incident angle of $16.0 \pm 2.0^\circ$ and speed of 30.0 ± 2.0 m/s. If possible, avoid using the test location(s) and test balls during this preparation stage.
2. Project each of the three test balls onto the test surface three times (nine impacts in total), moving impact location for each shot. If the surface is disturbed or damaged by the test (e.g. movement of clay particles), restore the surface or use a proximate impact location for the next shot.
3. For any surfaces that have an inherent directional pattern – such as natural or artificial grass – test shots should be fired in the typical directions of play, i.e. parallel to the length of the court.

Calculation of results

Include the following results in the test report for each impact:

v_{ix} = horizontal inbound velocity (m/s)

v_{iy} = vertical inbound velocity (m/s)

v_{fx} = horizontal outbound velocity (m/s)

v_{fy} = vertical outbound velocity (m/s)

e = coefficient of restitution (COR)

μ = coefficient of friction (COF)

T = mean ball temperature for test location/sample ($^\circ\text{C}$)

c = temperature coefficient (0.003)

e_T = adjusted COR for temperature T

a = pace perception constant (150)

b = mean coefficient of restitution for all surface types (0.81)

CPR = Court Pace Rating

where:

$$e = \frac{v_{fy}}{v_{iy}} \quad \mu = \frac{v_{ix} - v_{fx}}{v_{iy}(1 + e)} \quad e_T = e + c(23 - T) \quad \text{CPR} = 100(1 - \mu) + a(b - e_T)$$

The test value is the mean CPR for all impacts, excluding court markings. The variation is given by the maximum difference in the mean CPRs for each location, excluding the court markings.

Classification

Surfaces are categorised as follows:

Category	CPR
Slow	≤ 29
Medium-slow	30-34
Medium	35-39
Medium-fast	40-44
Fast	≥ 45

Table 2. Court Pace Rating categories.

As a guide, the tolerance in the mean CPR value for a court installed by experienced contractors using quality materials and conventional methods at a reasonable cost is ± 5 CPR points from the quoted value. This tolerance applies to a new court as/unless specified by the end-user. The variation in CPR between the test location means, excluding the court markings should not exceed 10 CPR points.

Note: CPR may vary depending on the nature of the materials that support the uppermost playing surface of a court.

The coefficients of friction and restitution of a surface are categorised as follows:

Category	COR	COF
High	≥ 0.85	≥ 0.71
Medium	0.79-0.84	0.56-0.70
Low	≤ 0.78	≤ 0.55

Table 3. Coefficient of restitution and friction categories.

Surfaces with a COR of less than 0.70 are not recommended for use as tennis courts. The maximum variation¹ in COR between the test location means, excluding the court markings, should be ≤ 0.05 . The maximum variation in COF between the test location means, excluding the court markings, should be ≤ 0.05 .

Figure 3 illustrates how friction (COF) and vertical restitution (COR) are combined to give CPR, using the equation on page 27. Surfaces are typically perceived to play 'faster' as CPR increases, which can result from a decrease in friction and/or restitution.

¹ Variation is expressed as a standard error, i.e. standard deviation of all tests divided by the square root of the number of tests.

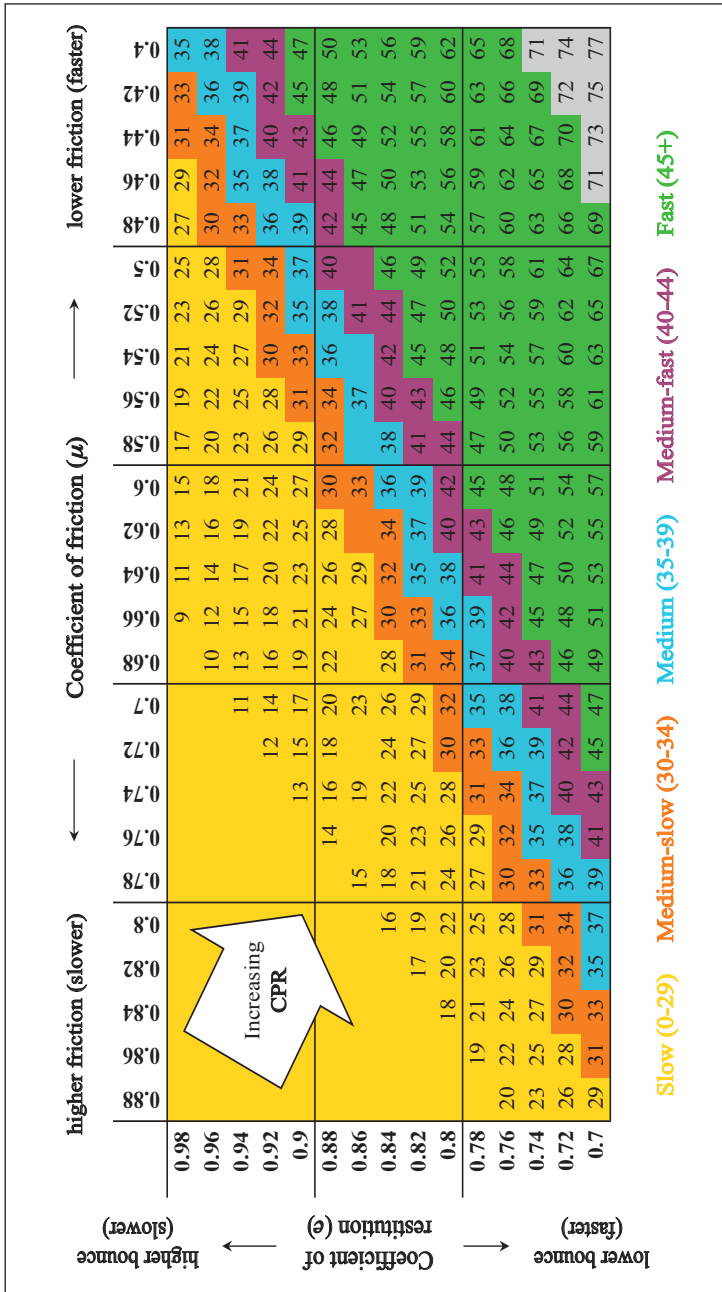


Figure 3. Court Pace Rating conversion chart.

5. BALL REBOUND (PREDICTIVE METHOD)

Although the rebound height of a ball is affected by its incident angle, a vertical drop can provide an indication as to the suitability of a surface for tennis.

To minimise the effects of environmental conditions and ball properties, the test surface is measured relative to the rebound height on a reference surface.

Apparatus

Test apparatus consists of:

- Standard ball.
- Reference surface, which shall be smooth, rigid and horizontal, e.g. polished granite block.
- A means to measure rebound height, calibrated to $\pm 1\%$, such as a measuring staff and video camera.

Calibration of apparatus

Check the height-measuring accuracy of the apparatus against a known standard prior to testing.

Test procedure

1. Drop the ball from a known height (at least 127 ± 1 cm) onto the reference surface five times and measure the rebound height (BHT) on each occasion, ensuring that there is no parallax error in the measurement.
2. Repeat step (1) on the test surface.

Note: The ball should be dropped in a manner that does not impart any impulse or spin.

Calculation of results

The Relative Percentage Rebound (RPR) is given by:

$$\text{RPR} = 100 \left(\frac{\text{BHT}_{\text{test}}}{\text{BHT}_{\text{ref}}} \right)$$

where:

BHT_{test} = rebound height on the test surface

BHT_{ref} = rebound height on the reference surface

The test value is the mean RPR for all impacts. For on-site tests, the variation is given by the maximum difference in the mean RPR for each location.

Recommendations

The preferred value for Relative Percentage Rebound is ≥ 80 . The variation in RPR between the test location means should be ≤ 10 .

6. EVENNESS (ITF CS 02/02)

The court surface should be free from any imperfection that causes an inconsistent ball bounce, allows the collection of water, or significantly increases the risk of injury to players.

Undulations in the court are measured relative to a rigid straight edge placed on the surface.

Apparatus

Test apparatus consists of:

- 3.0 m straight edge, made from box-section aluminium or equivalent.
- Wedge approximately 25 mm wide and 200 mm long, with marked height increments of 1 mm.
- Two supports for the straight edge, of equal height.

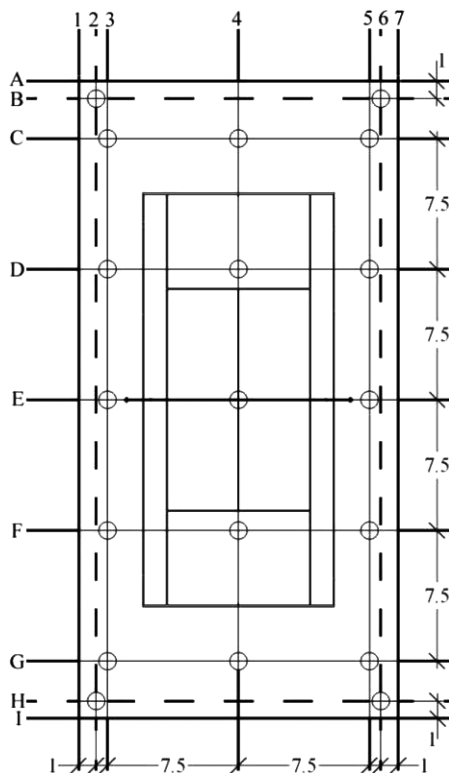
Calibration of apparatus

Devices used for evenness measurements should be calibrated annually for straightness of the edge against a known standard to ± 0.5 mm. Surveying-quality straight edges in serviceable condition are deemed appropriate. The straight edge can be checked by hanging a plumb line against the bottom edge. The wedge increments and supports can be measured using a calliper, calibrated against a known standard to ± 0.25 mm. Check for any damage to the straight edge and wedge prior to testing.

Test procedure

1. Lay the straight edge on the surface, parallel to the net, and look for deviations that warrant measurement, i.e. which exceed the recommended limit in Table 4.
2. If there are any hollows, measure the point of maximum deviation from the underside of the straight edge using the graduated wedge (see Figure 5). Ensure that the straight edge is resting on the court surface either side of the hollow.
3. If there are any isolated bumps or ridges, suspend the straight edge above the peak of the bump using supports at either side (see Figure 5). Measure the point of minimum deviation from the underside of the straight edge using the wedge and subtract this value from the height of the supports. This gives the height of the bump.
4. Measure the length of the deviation by moving the straight edge either side of the maximum point, parallel to the net, until the deviation no longer exceeds the recommended limit in Table 4.

5. Move the straight edge to an adjacent location and repeat steps (1) to (4), making sufficient measurements to inspect the Total Playing Area (TPA) of the court (see Figure 4).
6. Repeat steps (1) to (5) with the straight edge at right angles to the net.



Notes:

- a. The points A1, A7, I1 and I7 define the perimeter, which is typically kerbed.
- b. The Total Playing Area (TPA) is defined by B2, B6, H2 and H6, which are located 1 m inside the perimeter of the court. Where there is no perimeter, these points will be halfway between the court being measured and the neighbouring court, or 7.5 m wide of the middle of the net (whichever is the greater).
- c. The Principal Playing Area (PPA) is 15.0 m wide (parallel to the net) and 30.0 m long. The middle of the net shall coincide with the centre of the PPA. The PPA is defined by C3, C5, G3 and G5.

Figure 4. Plan view of a court showing recommended locations for measuring slope and planarity. All dimensions are given in metres.

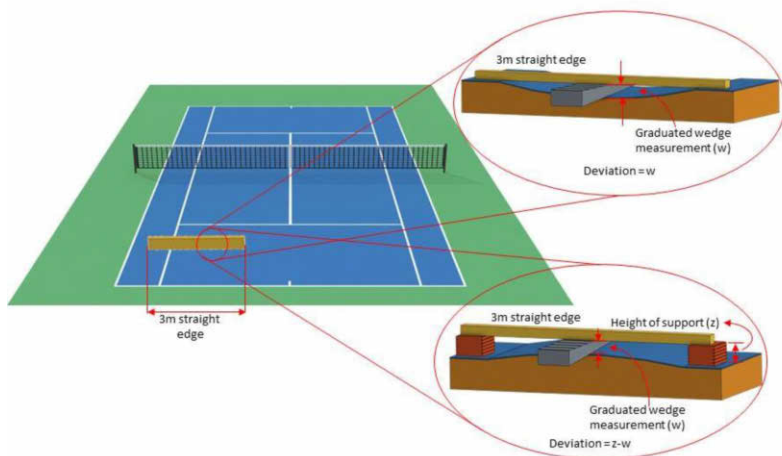


Figure 5. Schematic of method for measuring a hollow, or a bump or ridge (not to scale).

Calculation of results

Record the location, magnitude, direction (bump or dip) and orientation of all deviations outside the recommended limits. If any such deviation occurs in both test orientations (parallel to and at right angles to the net), then it should only be counted once. Deviations exceeding 1 m in length shall be counted per metre, or part thereof. For example, a deviation (above the recommended limit) 2.5 m long shall equate to three deviations. The test value is the number of deviations outside the recommended limits for the surface type.

Recommendations

Refer to Table 4.

	Acrylic/ Polyurethane	Artificial clay/ grass; carpet; hybrid clay	Asphalt/ concrete; other ¹	Clay	Grass
Evenness	6 mm		8 mm	6 mm	
Deviations ²	2 (PPA)/4 (TPA)		4 (PPA)/8 (TPA)	N/A ³	
Slope (max)	1:100 (1.00%)	1:120 (0.83%)		1:200 (0.50%)	
Planarity ⁴	± 15 mm from true (PPA) ± 30 mm from true (TPA)				

Notes: PPA = Principal Playing Area; TPA = Total Playing Area.

¹ Specifications are for porous constructions. For impervious constructions, see 'acrylic'.

² In no instance should any imperfection exist that could cause the ball to deviate significantly from its path on a level surface, or expose a player to a significantly increased risk of injury within the perimeter of the court.

³ Deviations on clay or grass over 6 mm should be corrected where possible.

⁴ Unless design, specification or construction necessitate otherwise.

Table 4. Evenness, slope and planarity recommendations for a tennis court.

7. SLOPE AND PLANARITY (ITF CS 03/03)

Ideally, a tennis court should be a flat surface lying in a single horizontal plane. The court may be sloped for drainage, but the single plane of the surface should always be maintained.

The slope should be oriented to minimise its effect on play. Thus, where a court must be sloped for drainage, a slope from side-to-side is preferred (see Figure 6). If necessary, the slope can be from end-to-end.

The slope is determined by measuring the ratio of change in elevation to horizontal distance. Planarity is measured relative to a hypothetical plane parallel to the slope of the court.



Figure 6. Preferred orientation of slope (side-to-side), if necessary.

Apparatus

Test apparatus consists of:

- A distance-measuring device, calibrated to $\pm 0.05\%$, such as a laser distance meter or a steel tape.
- A surveyor's level, calibrated to $\pm 1 \text{ mm}/10 \text{ m}$, and a measuring staff, calibrated to $\pm 0.25 \text{ mm}$. The level may be either a self-levelling rotary laser, which sweeps out a horizontal plane with a beam of visible or infrared light, an optical level, where the plane is defined by the horizontal axis of the instrument, or a pressurised hydrostatic altimeter.

Calibration of apparatus

The distance-measuring device, measuring staff and, if used, the pressurised hydrostatic altimeter must be checked against known standards. This should be carried out at appropriate intervals (typically annually) or if there is any reason to suspect that the device is inaccurate and/or has been damaged (e.g. if a laser distance meter has been dropped or left in the rain, or a steel tape has become kinked).

A surveyor's level can be checked using the standard 'two-peg' method: Place the level midway between two pegs at different heights 10 m apart and read the staff on each peg. Calculate the height difference between the pegs. Move the level 1 m past one of the pegs and read the staff on each peg and calculate the height difference again. The difference in the height differences is the collimation error in mm/10 m.

Test procedure

1. Using the distance-measuring device, find the *x*- and *y*-coordinates of the corners of the TPA (B2, B6, H2 and H6 in Figure 4). Temporarily mark a 7.5 m grid on the court surface (e.g. using coins). The centre point of the grid will be at the midpoint of the net, and the perimeter of the grid encloses the PPA (C3, C5, G3 and G5 in Figure 4).
2. Using the surveyor's level, establish a horizontal reference plane (or point) using a fixed datum, e.g. by placing the level near the centre of the court. Measure the vertical distance between the surface and the horizontal reference plane (or point) at the four corners of the TPA and each of the 15 points of the PPA grid (19 points in total) using the measuring staff (or the elevation unit of a pressurised hydrostatic altimeter).
3. Repeat the measurements in reverse order. Check any measurement for which the discrepancy between the two values exceeds 1 mm.
4. Measure the evenness of the court at the 19 points (refer to method ITF CS 02/02).

Calculation of results

Slope

1. Calculate the height difference for each pair of points along the two sides of the PPA (C3 and C5; D3 and D5, etc., in Figure 4) and take the mean of these five values.
2. Divide the mean by the width of the PPA (i.e. 15.0 m) to give the side-to-side slope.
3. Repeat this method to determine the end-to-end slope (using the points along the ends of the PPA, divided by 30.0 m) and the two corner-to-corner diagonal slopes (using the corner points of the PPA).
4. The maximum of these four gradients is the test value for slope.

Planarity

1. Calculate the mean of all the level measurements in the PPA to give the height of the centre of a hypothetical plane parallel to the court.
2. Calculate the heights of this hypothetical plane at each of the PPA and TPA points using the side-to-side and end-to-end slopes.
3. Use the evenness measurements from step (4) of the test procedure to correct the height, i.e. add the depth of a hollow, or subtract the height of a bump.
4. Calculate the height difference between the surface and the ideal plane at each measurement point. The maximum difference is the test value for planarity.

Note: A spreadsheet into which the measured coordinates and staff readings can be entered to calculate slope and planarity can be found at: www.itftennis.com/technical.

Recommendations

Refer to Table 4.

Note: A steeper maximum gradient is given for acrylic, impervious asphalt and concrete courts to prevent water from collecting on the court. In the case of clay and grass, a shallower gradient is required to minimise the erosion of the top dressing.

8. DIMENSIONS (ITF CS 04/02)

The court markings define the playing area of the surface and provide consistency with the Rules of Tennis and between courts.

The position of the court markings and net are checked using a distance-measuring device.

Apparatus

Test apparatus consists of:

- Distance-measuring device, calibrated to $\pm 0.05\%$, such as a laser distance meter or a steel tape.

Calibration of apparatus

Check the distance-measuring accuracy of the apparatus against a known standard annually.

Test procedure

1. Using the calibrated device, measure each of the distances listed in Table 5 (refer also to Figure 7). Follow the same procedure on both sides of the net to complete the court.
2. Repeat the measurements in reverse order. Check any measurement for which the discrepancy between the two values exceeds half of the applicable tolerance.

Note: All measurements of court markings should be made to the outside edge of lines, except those made to the centre serviceline and the centre mark, which are made to the centre of those lines. Measurements from the net should be taken using a plumb line hung from the top of the net, or a line tensioned between the centres of the net post holes.

Calculation of results

Calculate the mean of the two values measured for each distance. The tolerance for each test value (measured distance) corresponds to 0.1% of the distance measured, with a minimum tolerance of ± 5 mm. 10 mm is added to the tolerance for measurements involving the net, due to the thickness and movement of the net and the uncertainty in the measurement of the net posts.

Recommendations

Refer to Table 5.

Measurement	Description	Criterion (m)	Tolerance (mm)	Range (m)
DC	Distance between doubles sidelines	10.973	11	10.96-10.98
Dd, Cc	Doubles sidelines to singles sidelines	1.372	5	1.37-1.38
dJ	Singles sideline to centre mark	4.115	5	4.11-4.12
dc, GF	Distance between singles sidelines	8.233	8	8.22-8.24
GH	Singles sideline to centre serviceline	4.115	5	4.11-4.12
ad, bc	Net to baseline	11.887	22 ^a	11.87-11.91
aG, bF	Net to serviceline	6.401	16 ^a	6.38-6.42
dd', cc'	Distance between baselines	23.774	24	23.75-23.80
GG', FF'	Distance between servicelines	12.802	13	12.79-12.81
NN ^{rb}	Length of net	12.802	23 ^a	12.78-12.82
XN ^{b,c}	Middle of net to net post	6.401	16 ^a	6.38-6.42
DC', CD'	Full-court diagonal (doubles)	26.184	26	26.16-26.21
C to backstop ^f	Baseline to backstop	$\geq 6.40^d$	N/A	N/A
C to sidestop ^f	Baseline to sidestop	$\geq 3.66^e$	N/A	N/A
X to ceiling	Ceiling height at net	≥ 9.0	N/A	N/A
J to ceiling	Ceiling height at baseline	≥ 5.4	N/A	N/A

Notes: Movement of grass during the application of court markings shall be taken into account when assessing the results.

a. 10 mm added to the tolerance for measurements involving the net.

b. N is measured from the centre of the net posts.

c. In cases where the position of X cannot be located precisely, for instance due to anchoring of the centre strap, use a reference point midway across the centre serviceline.

d. Applies to international competition. For recreational and club play, the recommended minimum distance is 5.48 m.

PART C – COURT PACE CLASSIFICATION

1. COURT PACE CLASSIFICATION PROGRAMME

1.1 INTRODUCTION

The ITF Court Pace Classification Programme has been developed to assist purchasers of tennis surface products to determine the type and speed of surface most suited to their requirements. As described in Part B, the ITF classifies surfaces into one of five categories according to its Court Pace Rating:



A surface product included on the list of ITF Classified surfaces is classified purely on the basis of its Court Pace Rating. ITF Classification does not imply any form of ITF approval or endorsement.

Any manufacturer, contractor or facility owner may apply for classification and inclusion on the ITF list. The ITF reserves the right to refuse an application for classification of a surface that it deems is not suitable for the game of tennis, whether in relation to its test values or any other reason. Further details on the eligibility of surface products are available to view and download from the ITF website (www.itftennis.com/technical).

ITF Classification is valid for three years.

1.2 APPLICATION TO AN ITF ACCREDITED LABORATORY

To have a product assessed for inclusion on the ITF Classified surfaces list, a company shall appoint an ITF Accredited laboratory to undertake court pace measurements on the surface, either on-site or in the laboratory. Contact details for ITF Accredited laboratories can be viewed on the ITF Technical website:
www.itftennis.com/technical/apply/court-classification/accredited-laboratories.aspx.

When commissioning the court pace assessment the company requesting the tests shall provide a detailed specification of the court/surface construction and (for laboratory testing) samples of the surface, including any loose particulate materials, to the ITF Accredited laboratory. The infill rate (in kg/m³), free pile/over-fill height (in mm) and infill method, including any necessary humidification, should be provided in the specification (where applicable).

The laboratory requires either three samples, each of minimum dimensions 0.5 m × 0.5 m, or (in the case of infilled and carpet surfaces) one sample which is a minimum of 1 m × 1 m. In addition, one identical sample (0.5 m × 0.5 m) shall be sent to the ITF Technical Centre for testing by the ITF if necessary. The ITF Accredited laboratory and/or the ITF may refuse to test samples which are damaged or badly prepared.

Tests on the surface shall be conducted in accordance with test method ITF CS 01/02 described in Part B, Section 4 of this document. Where samples with an inherent directional pattern are provided for laboratory testing, the supplier shall indicate on the sample the direction in which the surface should be tested.

Upon completion of the test, and receipt of payment of the testing fee, the ITF Accredited laboratory shall submit the test results to the ITF for review, save in exceptional circumstances that shall be documented by the laboratory and provided to the ITF at the same time as the results.

Test results should be received by the ITF within one month of the test date. Once approved by the ITF, the ITF Accredited laboratory shall issue the results to the customer.

1.3 APPLICATION FOR ITF CLASSIFICATION LISTING

Upon receipt of valid test results from an ITF Accredited laboratory, the customer may apply to the ITF Technical Centre using an online ITF Classification application form in the ITF TennisNET Portal (<https://tennisnet.itftennis.com>). Once submitted, the ITF Technical Centre will issue an invoice for the classification fee.

It is important to note that applications for classification must be received by the ITF within one month of the issue date of an on-site test report, or within six months of the issue date of a laboratory test report. Applications received outside of these timescales will not be accepted for the purposes of ITF Classification.

The uncertainty in the pace rating obtained from test method ITF CS 01/02 is ± 2 CPR points, established from 'round-robin' laboratory testing of samples between ITF Accredited laboratories. In recognition of this uncertainty, if the mean CPR value for the test is ≤ 2 points from an adjacent category, the customer will be given the choice between the two categories. A final report will then be issued to the customer containing the original and amended category.

The classification fees are shown below, including discounts available to members of the ITF Foundation¹.

¹ Conditional on company being a member of the ITF Foundation for the previous two calendar years. Information on membership of the ITF Foundation can be obtained on request to the ITF Technical Centre.

Classification Fees per product brand	Non- Foundation Member	Discounted fees for ITF Foundation	
		General Member	Supporting Member
1 st product per 3 calendar years	US\$ 4,350	US\$ 2,700	US\$ 2,170
2 to 5 products per 3 calendar years	US\$ 3,930	US\$ 2,440	US\$ 1,960
6+ products per 3 calendar years	US\$ 3,020	US\$ 2,170	US\$ 1,740

Upon receipt of payment of the classification fee the surface will become ITF Classified and a certificate will be issued. The surface will be listed on the ITF website (www.itftennis.com/technical).

ITF Classification of court surface products is valid for three years from date of listing. If a company wishes a product to remain on the ITF Classified list beyond that 3-year period, it shall arrange for the product to be reassessed by an ITF Accredited laboratory no more than six months, and no less than three months, prior to expiry.

A supplier of an ITF Classified product may apply for it to be listed under a different brand name by assimilation. The full classification fee will apply, noting that the expiry date will be the same as the original classified surface. In addition, the supplier may request the listing of an ITF Classified product in the name of a distributor, for which the full classification fee per distributor will apply.

2. ITF CLASSIFIED SURFACES

The ITF has devised a table of surface descriptions in order to standardise the way surfaces are described as to their type. The descriptions relate only to court construction, and not to performance characteristics.

Type	Description
Acrylic/Polyurethane ¹	Textured, pigmented, resin-bound coating.
Artificial clay ²	Sand-dressed and/or rubber-dressed surface with the appearance of clay.
Artificial grass ²	Synthetic surface with the appearance of natural grass.
Asphalt ³	Bitumen-bound aggregate.
Carpet	Textile or polymeric material supplied in rolls or sheets of finished product.
Clay ⁴	Unbound mineral aggregate.
Concrete ³	Cement-bound aggregate.
Grass	Natural grass grown from seed.
Hybrid clay	Clay-dressed systems supported by a carpet matrix.
Other	E.g. modular systems (tiles), wood, canvas.

Notes:

All surfaces may be porous or non-porous, with the exception of 'Clay' and 'Grass', which are always porous.

¹ Normally forms only the uppermost few millimetres of a court.

² "Appearance" relates only to the form of the uppermost surface material and not other characteristics (e.g. colour). These surfaces are typically composed of a carpet matrix dressed/filled with sand and/or rubber aggregate.

³ Used only when the material itself forms the playing surface. When used as a base for other surfaces (e.g. acrylic), reference will be made only to the playing surface.

⁴ This term denotes a type of surface that is constructed from naturally-derived materials, and includes an unbound fine gritty material as the uppermost (playing) layer, e.g. fast-dry. The integrity of the surface shall not be reliant on the addition of a carpet or membrane layer to the structure.

Court surface products that have been classified by the ITF are awarded pace ratings fall into one of the following five categories:

- Category 1 (slow)
- Category 2 (medium-slow)
- Category 3 (medium)
- Category 4 (medium-fast)
- Category 5 (fast)

Note: ITF Classification does not imply any form of ITF approval or endorsement.

The list of ITF Classified court surface products is published on the ITF website (www.itftennis.com/technical). As additional surface products are added, the website is updated.

ITF Classification is valid for three years.

PART D – ITF RECOGNITION OF TENNIS COURTS

1. INTRODUCTION

ITF Recognition is an acknowledgement that a court meets the recommendations provided in the *ITF Guide to Test Methods for Tennis Court Surfaces* (Part B of this document).

ITF Recognition is targeted at venues hosting elite-level competitions where the standard of play demands the specification of precise playing characteristics, e.g. at international tournaments, national/regional tennis centres.

There are two levels of ITF Recognition:

One-Star ITF Recognition – the court is tested for quality of installation.

Two-Star ITF Recognition – in addition to the One-Star tests, the court is tested for pace.

To obtain One-Star ITF Recognition, courts shall be tested by an ITF Accredited laboratory or a company that has demonstrated to the ITF's satisfaction that it has the skills, equipment and experience to conduct the tests, or the ITF Technical Centre.

Testing to obtain Two-Star ITF Recognition can only be undertaken by an ITF Accredited laboratory or the ITF Technical Centre.

ITF Recognition is retained until the court is resurfaced or for 10 years, whichever is the sooner. However, the results of the tests are only valid for the day of testing. Properties of the court may change due to factors such as ambient conditions, use and maintenance.

IMPORTANT NOTE: ITF Recognition is not mandatory, nor does it imply any form of ITF approval or endorsement.

2. ITF RECOGNITION

2.1 One-Star ITF Recognition

To obtain One-Star ITF Recognition, the court is tested for quality of installation:

- Visual inspection. The court is inspected for visual flaws.
- Evenness (ITF CS 02/02). Undulations in the surface of the court are measured.
- Slope and planarity (ITF CS 03/03). The height of the surface is surveyed at a range of locations around the court.
- Dimensions (ITF CS 04/02). The positions of the lines and net are measured.

All test results must meet the recommendations contained in the *ITF Guide to Test Methods for Tennis Court Surfaces* to be eligible for One-Star ITF Recognition. (See Part B of this document).

Testing for One-Star ITF Recognition shall be conducted by an ITF Accredited laboratory or other company approved in advance by the ITF.

Recipients of One-Star ITF Recognition shall receive a certificate from the ITF, confirming that the court(s) tested meet the recommendations of the *ITF Guide to Test Methods for Tennis Court Surfaces*.



2.2 Two-Star ITF Recognition

To obtain Two-Star ITF Recognition, the average Court Pace Rating (CPR) of the court must be within 5 points of the ITF Classified value for the surface product (ITF CS 01/02) in addition to fulfilling the requirements for One-Star ITF Recognition.

If the surface product is not already classified, the product supplier may apply for ITF Classification of the surface product based on the average results of all courts using the product tested on-site. The full ITF Classification fee will apply and classification will be valid for three years.

Note: Two-Star ITF Recognition cannot be granted to courts where the surface product is not classified under the ITF Court Pace Classification Programme.

Recipients of Two-Star ITF Recognition shall receive a certificate from the ITF, confirming that the court(s) tested meet the recommendations of the *ITF Guide to Test Methods for Tennis Court Surfaces*.



Testing for Two-Star ITF Recognition must be conducted no earlier than one month prior to the One-Star tests.

3. APPROVAL OF COMPANIES TO CONDUCT ONE-STAR ITF RECOGNITION TESTS

Applicants for One-Star ITF Recognition may engage a company or individual other than an ITF Accredited laboratory to conduct the required testing.

Prior to commencing work, any such company must be assessed by the ITF against the following criteria, typewritten (in English):

- Confirmation that the company possesses equipment with the required accuracy to conduct the tests for evenness, slope and planarity, and dimensions.
- Information on company accreditation to a nationally- or internationally-recognised quality management system, or other relevant qualifications (e.g. membership of professional bodies).
- Evidence that the company has the knowledge and capability to conduct the on-site tests. A reference list of tennis courts tested in the preceding two years may be supplied in this regard, plus two completed ITF test reports. If the company has no prior experience of testing tennis courts, the company will be requested to conduct all One-Star tests on a minimum of two (local) courts, and complete an ITF report, which it will send to the ITF for review.
- Details of any work undertaken for National or International Governing Bodies of Sport, Sports Associations, Councils or Federations, including contact details.

The information must be submitted on an ITF form which is available on request by email to technical@itftennis.com or by download from the ITF website (www.itftennis.com/technical). Upon obtaining ITF approval, the company will be listed on this website, and may then conduct One-Star ITF Recognition testing under this programme.

To maintain their approved status, the assessor shall submit at least one test report within the three-year recertification period. The report does not need to be at the request of a customer (i.e. it can be produced without an application for ITF Recognition).

Note: The ITF reserves the right to deny or remove companies from the approved list at any time

4. ACCREDITATION OF LABORATORIES

Only ITF Accredited laboratories or the ITF Technical Centre are permitted to conduct pace testing for Two-Star ITF Recognition and ITF Classification. In addition, the ITF Accredited laboratory must be capable of conducting all necessary testing for One-Star ITF Recognition.

4.1 Criteria for Accreditation

The laboratory should be an organisation that includes a test laboratory devoted to the research and development of sports surface science, and shall have achieved a position of influence and responsibility in the field of sports surfaces. Its work shall include the testing and evaluation of sports surfaces and related materials, both in the laboratory and in the field, with well-documented records.

The laboratory shall be independent of any company manufacturing, supplying or installing sports surfaces, or manufacturing or supplying sports equipment.

The work of the laboratory must be recognised as being of high quality, maintained by operating a comprehensive policy of calibration of all its relevant test equipment. Evidence of compliance to ISO 9001, ISO 17025 or another inter- nationally-recognised quality assurance system is required.

The laboratory must confirm in writing its willingness to participate regularly in 'round-robin' testing, presentations of papers and publications, attendance at meetings, and other scientific and technical matters, at the ITF's request.

The laboratory must have access to facilities capable of undertaking all tests detailed in the *ITF Guide to Test Methods for Tennis Court Surfaces* (Part B of this document).

4.2 Application for ITF Accreditation

Laboratories applying for ITF Accreditation must provide the following information to the ITF in English:

- A list of test equipment relevant to the testing of tennis surfaces.
- A diagram of its organisational structure, together with the Curriculum Vitae of its nominated representative(s) and brief details of the qualifications and experience of other relevant staff on the organisational structure.
- A reference list of tennis facilities and surfaces tested in the preceding two years.
- A list of relevant publications, technical papers and articles produced by, or contributed to by, the applicant laboratory in the preceding two years.
- Details of any work with National or International Governing Bodies of sport, sports associations, councils or federations.
- Membership of National or International Standard Organisations, e.g. ISO, CEN, BSI, DIN, ASTM or their Working Groups.
- Evidence that the company is accredited to an internationally-recognised quality management system.

All laboratories applying for ITF Accreditation shall be inspected by a representative of the ITF. The laboratory shall be required to undertake round-robin testing as directed by the ITF Technical Centre. The applicant laboratory shall meet all costs and expenses involved in this procedure.

Note: The ITF reserves the right to deny or remove ITF Accreditation at any time.

5. PROCEDURES AND FEES FOR OBTAINING ITF RECOGNITION

Any manufacturer, installer or facility owner may apply for ITF Recognition. A request for ITF Recognition shall be made on an application form submitted to the ITF. The form is available on request by email to technical@itftennis.com or by download from the ITF website (www.itftennis.com/technical). The ITF shall issue an invoice for the ITF Recognition fee of US\$ 500 (the “Recognition Fee”) per facility for the first court and US\$ 100 for each additional court to be tested on consecutive days.

The Recognition Fee is non-refundable and will apply to the applicant(s) that has paid for the testing (the “Primary Applicant”). Any subsequent applications for ITF Recognition from any other organisation(s) that contributed to the manufacture and/or construction of the court (the “Secondary Applicant”) are subject to a fee of US\$ 2,000, and must provide evidence of their involvement in the manufacture and/or construction. Applications from more than one company, whether as Primary Applicants or Secondary Applicants, are subject to the relevant fee from all applicant companies.

Note: The ITF has reduced the Recognition Fee payable by the Primary Applicant, in recognition of the costs incurred in testing of the court(s).

Applicants should nominate an ITF Accredited laboratory and/or ITF Recognition Assessor to conduct the necessary testing, with whom testing fees should be agreed directly.

Note: Testing fees are separate from the Recognition Fee.

On completion of the tests, the laboratory or assessor shall return the completed test report to the ITF, and the ITF will make the sole determination as to whether the court(s) shall be granted ITF Recognised status. Where more than one court is tested, only those courts that have passed all tests will be granted ITF Recognised status.

ITF Recognition (whether One-Star or Two-Star) will only be granted to courts for which the report(s) is/are received by the ITF within one month of the initial test date. That is, where an applicant wishes one or more courts to be tested for One-Star and Two-Star ITF Recognition at the same time, all such testing must be completed, and the report(s) received by the ITF, within a one-month period.

The ITF will endeavour to inform the applicant of the result of all tests within two weeks of receipt of the test report(s). A certificate will be issued for those courts that pass all tests, and the facility/court(s) will be listed on the ITF website (www.itftennis.com/technical).

6. VALIDITY OF ITF RECOGNITION

The results of the tests for which ITF Recognition is awarded are valid on the day of the test only, which shall be stated on the test report and certificate. ITF Recognition shall cease to be valid once a court is resurfaced or after 10 years, whichever is the sooner. Listings of ITF Recognised facilities and/or companies/individuals are published on the ITF website.

Note: The ITF reserves the right to deny or remove ITF Recognised status at any time.

7. ITF RECOGNITION SUPPLIER STATUS

Each applicant who is granted ITF Recognition will receive a certificate. The venue and court(s) will also be listed on the ITF Technical website. For Two-Star ITF Recognised courts, the product brand name shall also be published, including a link to the listing of that product in the ITF Court Pace Classification Programme.

Court surface suppliers and/or installers who regularly and continually obtain ITF Recognition will be acknowledged as follows:

ITF Recognition Elite Silver
– 10 ITF Recognition certificates



ITF Recognition Elite Gold
– 50 ITF Recognition certificates



Eligibility for Elite status will be assessed over the previous 5-year period. ITF Elite Silver and Elite Gold status are valid for five years from date of issue, and the recipients will receive a certificate and be listed on the ITF Technical website. A logo will be provided to enable Elite status holders to promote themselves as such.

In respect of USA-based installers, only companies which have obtained Certified Tennis Court Builder (CTCB) accreditation from the American Sports Builders Association (ASBA) are permitted to hold Elite status certificates.

Note: The ITF reserves the right to deny or remove ITF Recognised supplier/installer status at any time.



The ITF Foundation is comprised of international manufacturers and companies involved in the tennis industry. The ITF and the ITF Foundation work together for the development and promotion of the game.

Supporting Members:



General Members:

American Sports Builders Association

Artengo

Babolat

Condor Grass

Har-Tru

Head

Major Sports

Mapei

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Sporter

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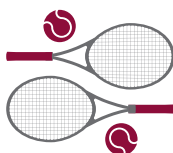
Tensindo Sports

TigerTurf

Vigano Pavitex

WSP Textiles

Any organisation interested in joining the ITF Foundation should contact:
International Tennis Federation Bank Lane Roehampton London SW15 5XZ
tel: +44 (0)20 8878 6464 fax: +44 (0)20 8878 7799 email: foundation@itftennis.com



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BANK LANE ROEHAMPTON

LONDON SW15 5XZ UK

REGISTERED ADDRESS: PO BOX N-272, NASSAU, BAHAMAS

TEL: +44 (0)20 8878 6464

FAX: +44 (0)20 8878 7799

WEB: WWW.ITFTENNIS.COM

