ITF Court Surface Classification Scheme

ISSS Technical Meeting

Nyon, October 2002

Introduction

Introduction

- No way to measure performance characteristics and, therefore:
  - For manufacturers to describe their products,
  - For customers to specify their needs.

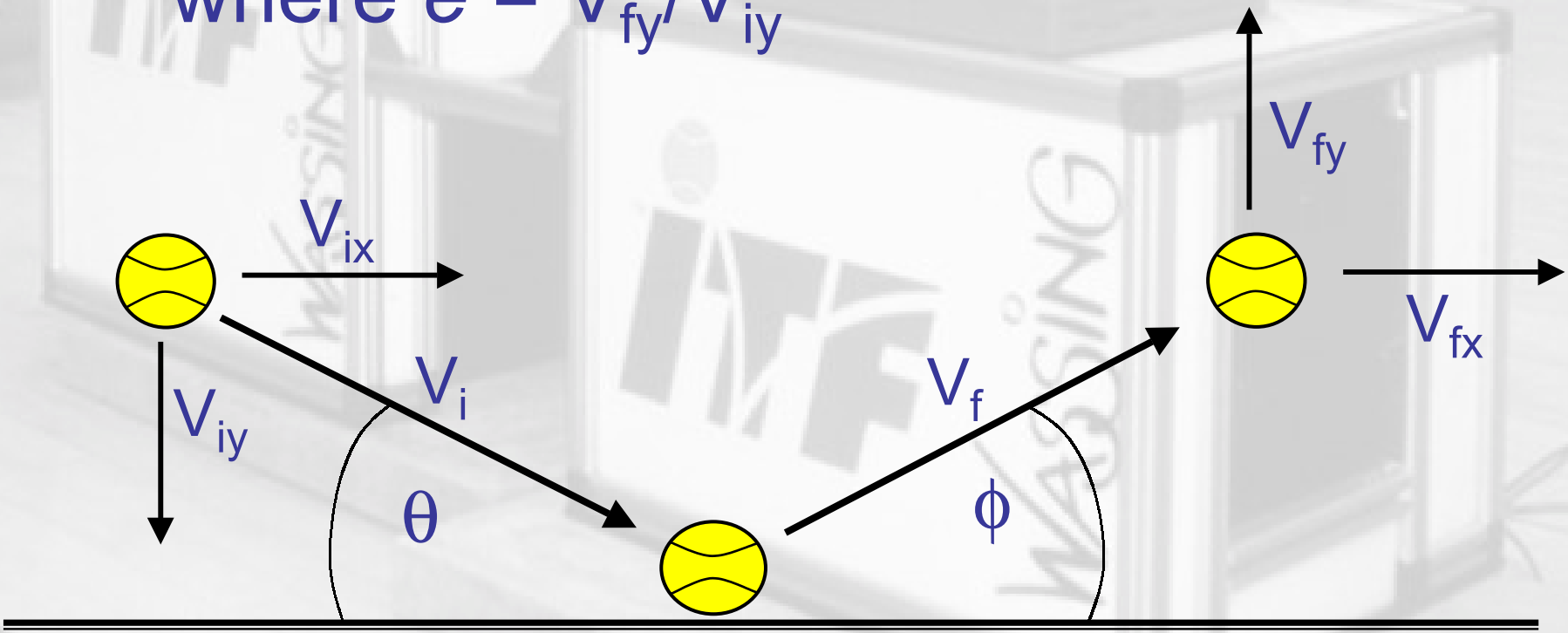
Introduction

- 1996 – ITF working group.
- Aims of research programme:
  - To identify the key sports performance characteristics of tennis court surfaces,
  - To establish a common system of test methods to evaluate these characteristics.

What to Measure?

Surface Pace = $(V_{ix} - V_{fx})/(1 - e)V_{iy}$

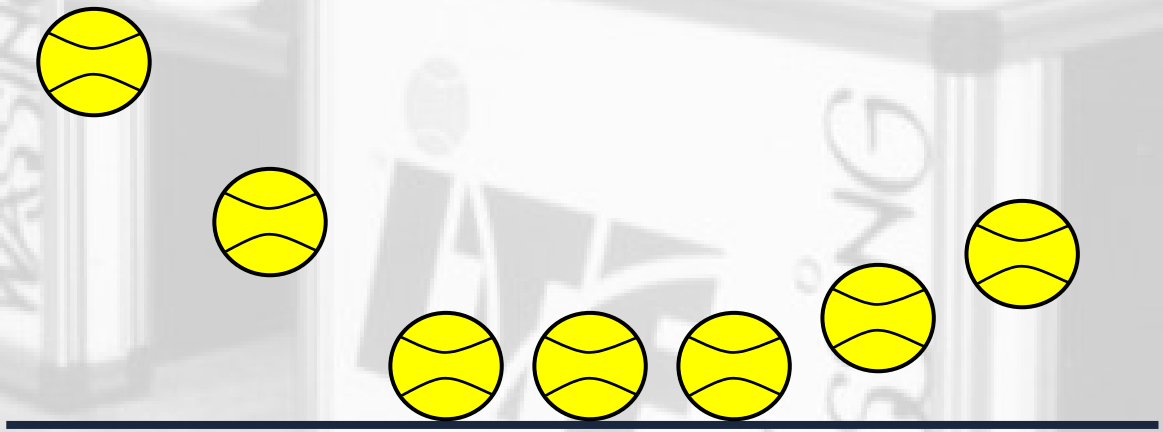
where $e = V_{fy}/V_{iy}$



Surface ‘Pace’

Assumptions

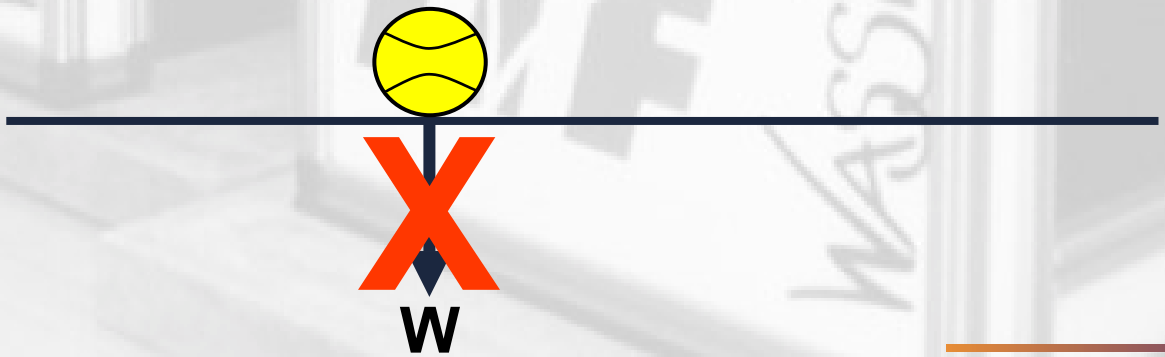
- The ball slides throughout impact,



Surface ‘Pace’

Assumptions

- Weight of the ball is ignored…



Surface 'Pace'

Surface Pace Rating

$(V_{ix} - V_{fx})/(1 - e)V_{iy}$

$= \mu$ (coefficient of friction)

$100 \times (1 - \mu)$

$1 < SPR < 100$

Surface 'Pace'

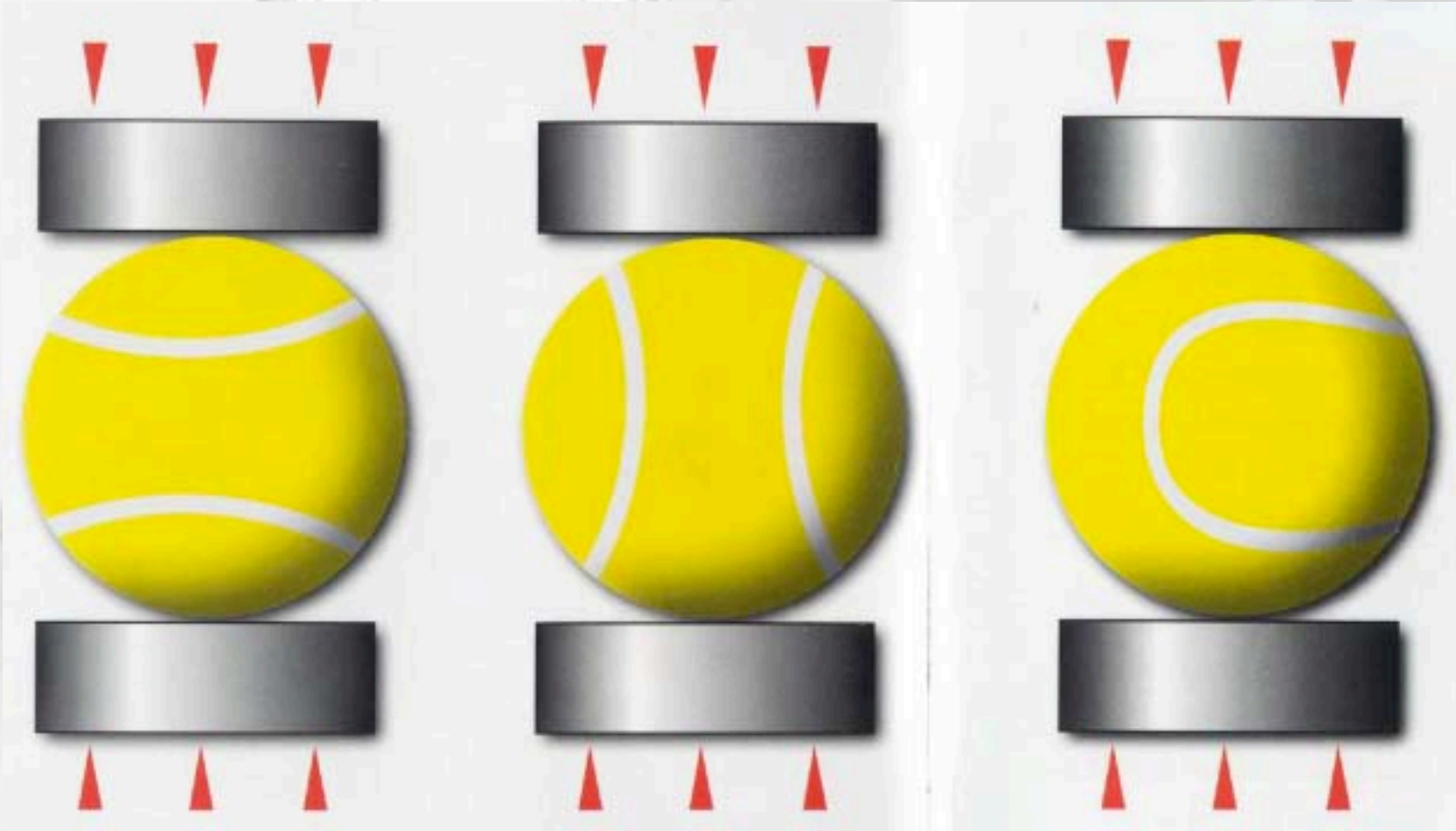
Measurement

- Realism – use tennis ball and tennis court surface.
- Ball speed – ball must slide during contact with the surface.
- Validity – measuring equipment must be accurate and precise.
- Aerodynamics – measure close to time of impact.

Test Ball Specification

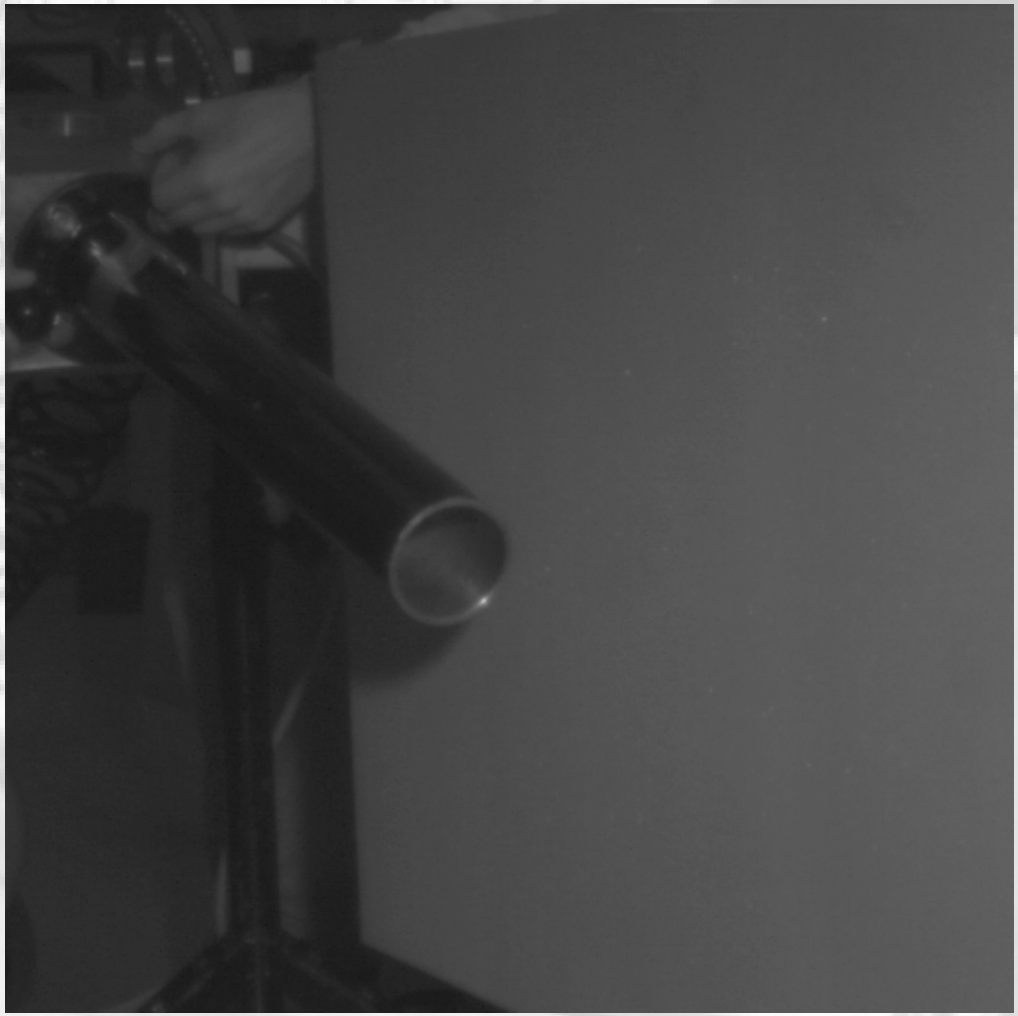
	Test Ball.	ITF Rules of Tennis
Type of Ball:	Pressurised	
Ball weight:	57.6 +/- 0.3 g	56.7 - 58.5 g
Ring gauge diameter:	minimum 67.072 mm	minimum 65.405 mm
	maximum 67.865mm	maximum 68.580 mm
Forward deformation:	6.413 +/- 0.317 mm	5.588 - 7.366 mm
Rebound on concrete (mean of five tests):	1.410 +/- 0.010 m	1.346 - 1.473 m

Pre-Compression

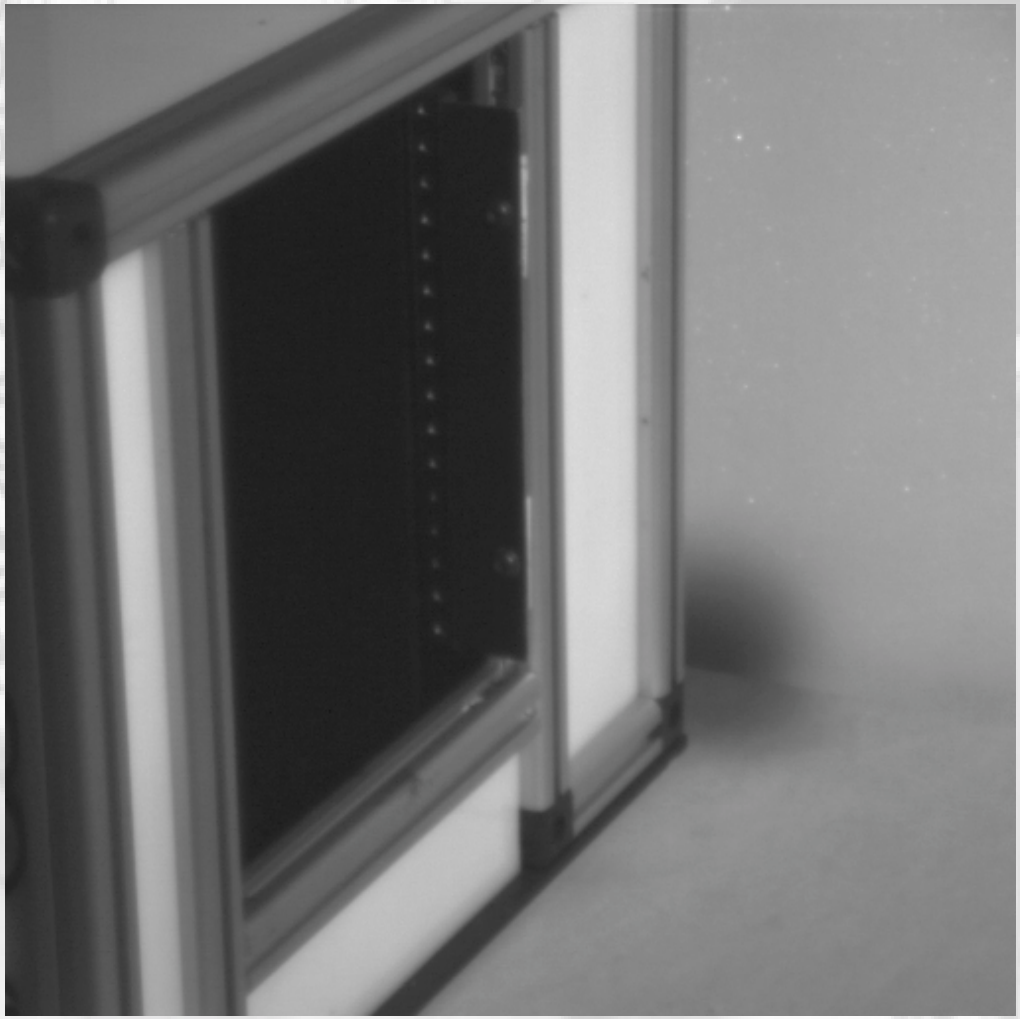


Surface ‘Pace’ Measurement

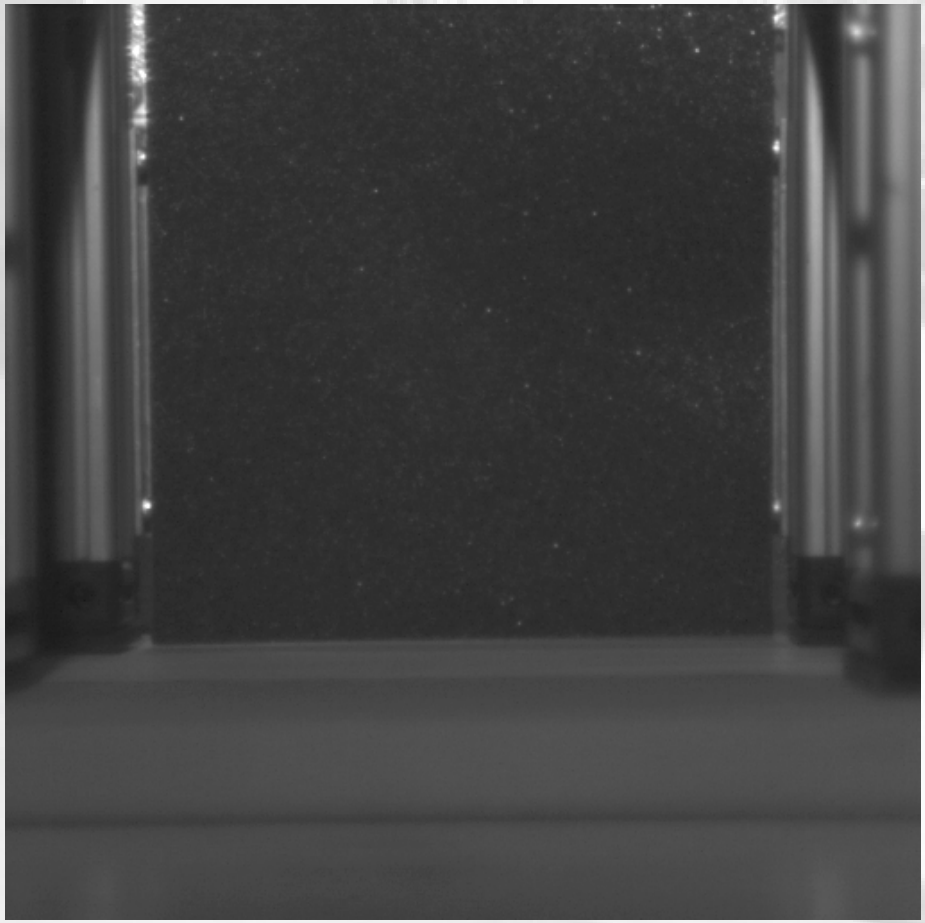
Surface ‘Pace’

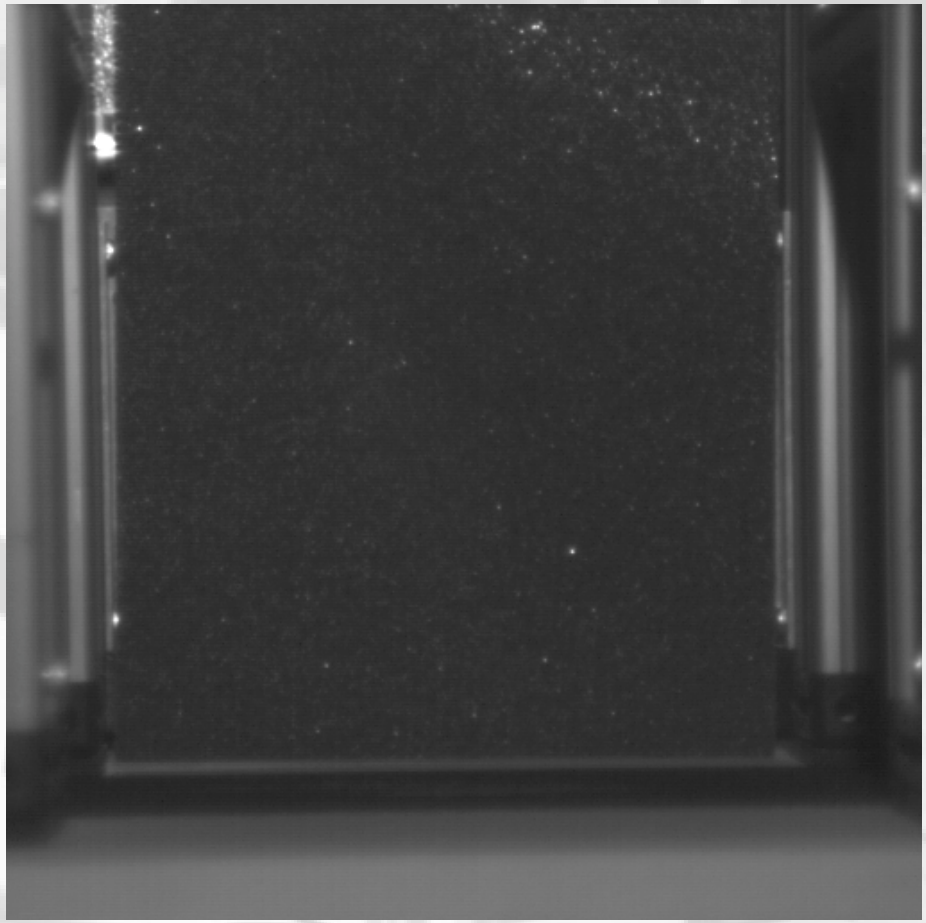


Surface ‘Pace’



Surface ‘Pace’





Sestee II

File Results Configuration Protocol Info

F1 Measure | Show Results

DEMO MODE
Expert mode

Stored Results

e	f	Title	Surface
0.778	0.743	Standard surfac	P120 Clot
0.756	0.715	Standard surfac	P120 Clot
0.782	0.690	Standard surfac	P120 Clot
0.815	0.813	Standard surfac	P80 Cloth
0.820	0.827	Standard surfac	P80 Cloth
0.792	0.805	Standard surfac	P80 Cloth
0.795	0.829	Standard surfac	P80 Cloth
0.752	0.815	Standard surfac	P80 Cloth
0.837	0.796	Standard surfac	P80 Cloth
0.801	0.854	Standard surfac	P80 Cloth
0.787	0.798	Standard surfac	P80 Cloth
0.791	0.824	Standard surfac	P80 Cloth
0.817	0.811	Standard surfac	P80 Cloth
0.873	0.787	Standard surfac	P60 Cloth
0.856	0.790	Standard surfac	P60 Cloth
0.817	0.815	Standard surfac	P60 Cloth
0.867	0.784	Standard surfac	P60 Cloth
0.842	0.789	Standard surfac	P60 Cloth
0.820	0.827	Standard surfac	P60 Cloth
0.808	0.824	Standard surfac	P60 Cloth
0.838	0.810	Standard surfac	P60 Cloth
0.818	0.827	Standard surfac	P60 Cloth
0.807	0.833	Standard surfac	P60 Cloth

Measure | Memo | Graphics | Details

Description

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Surface: P60 Cloth-backed Date: 20/09/02 Time: 14:05:38

Title: Standard surface User:

Velocities

v1	29.91 ± 0.04 m/s	v2	16.47 ± 0.02 m/s
vt1	28.53 ± 0.04 m/s	vt2	14.75 ± 0.02 m/s
vn1	-9.16 ± 0.02 m/s	vn2	7.39 ± 0.01 m/s

Angles

α	-17.799 ± 0.065 °	β	26.609 ± 0.063 °

Impact coefficients

e	0.807 ± 0.003	f	0.833 ± 0.005
Pace	16.725 ± 0.000		

Miscellellaneous

Sliding case (<1)	1.16 ± 0.00	
Sliding length	97.08 ± 1.75 mm	
Contact duration	4.72 ± 0.05 ms	
Asymmetry	11.2 ± 0.0 mm	
Radius of the ball (1;2)	32.82 ± 0.09 mm	33.84 ± 0.10 mm

Export file: C:\Program Files\Wassing\Sestee\databack

ESC Cancel | F5 Repeat measure | F2 Save

Browse | Sort by Number | Filter off | Paint graphis

Results

File Print Export Sort Filter

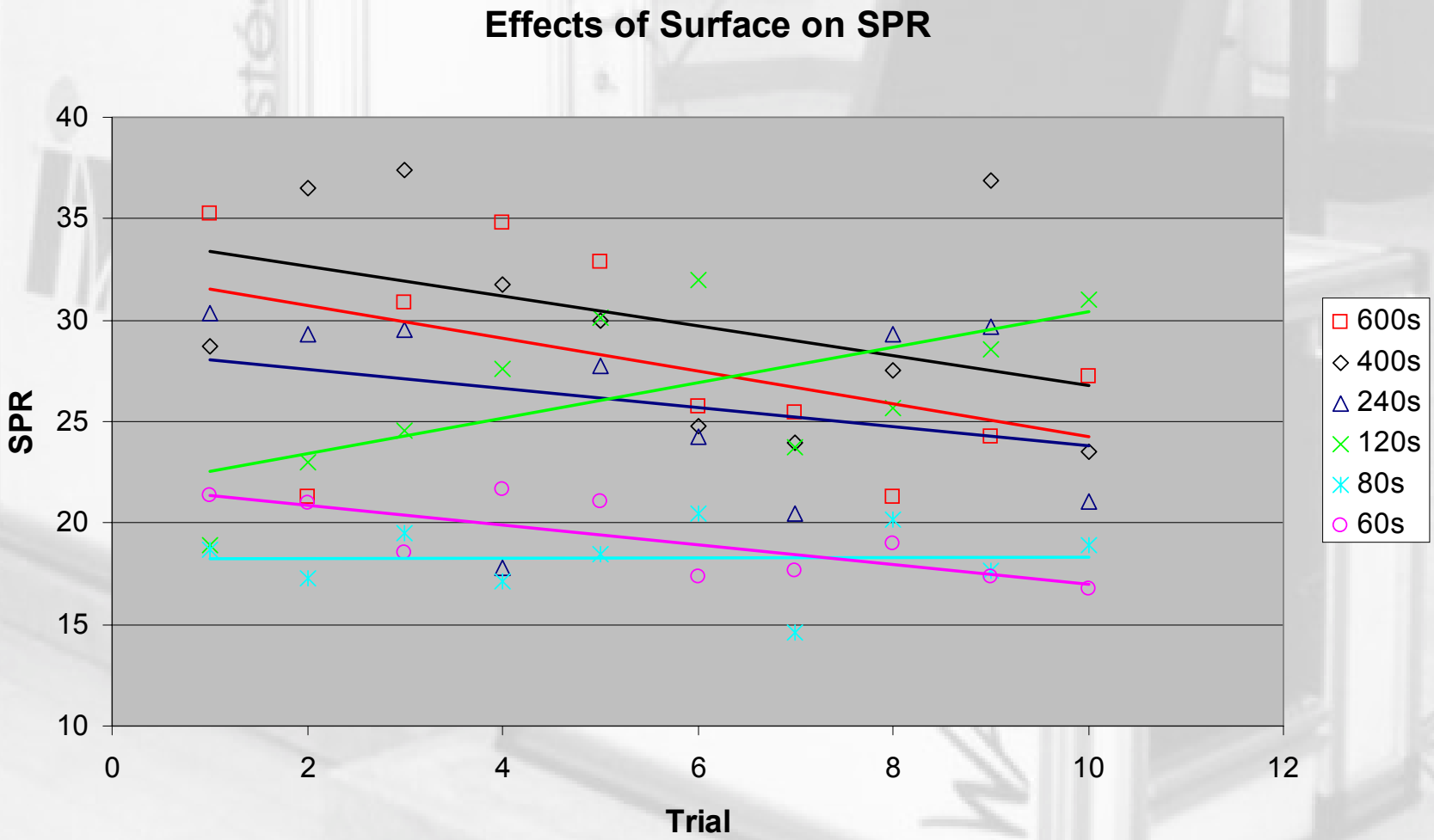
F3 Print F6 Export

Stored Results

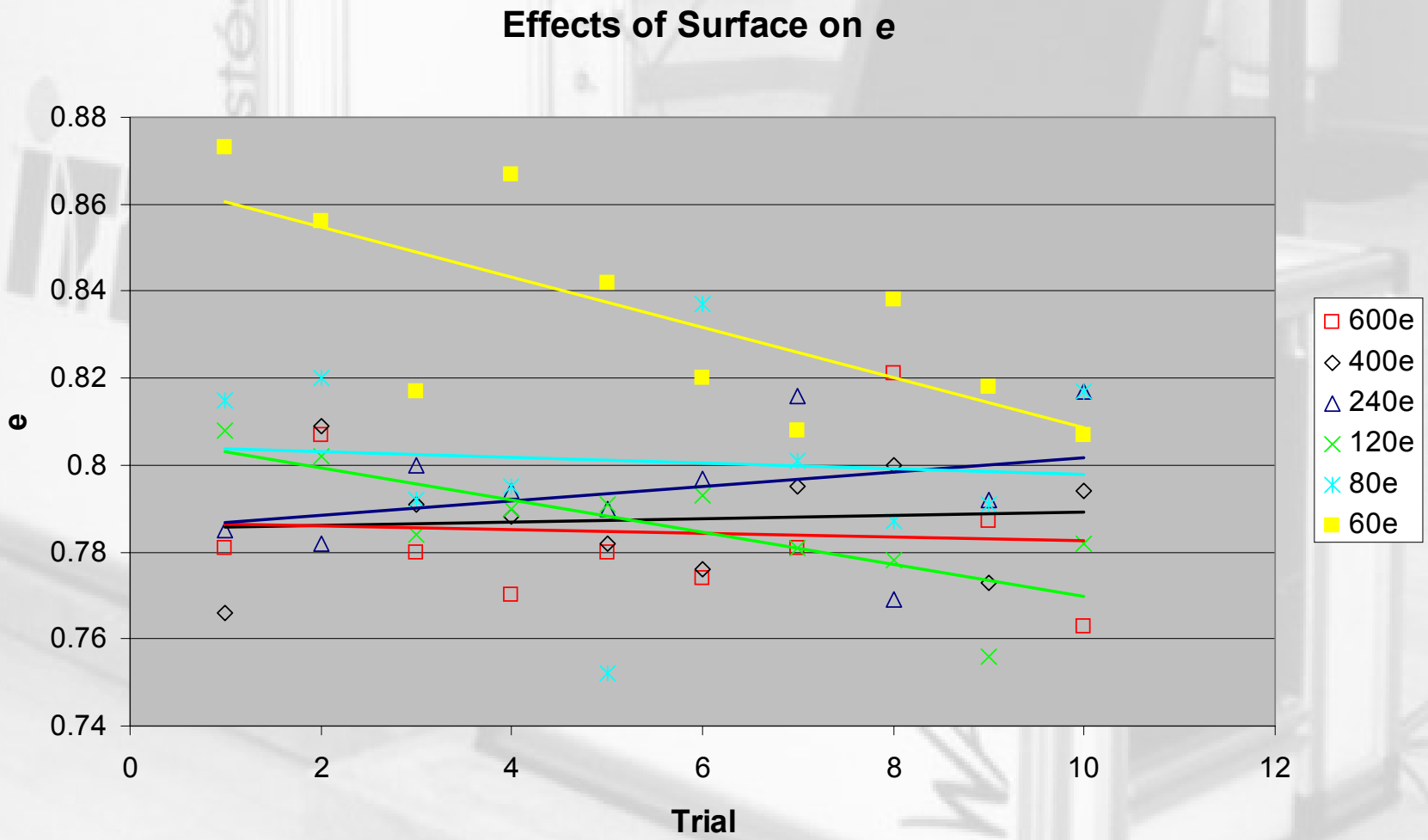
Surface	e	f	No	v1	vt1	vn1	v2	vt2	vn2	a	b
P240C Naylors waterproof abrasive paper	0.800	0.705	127	30.254	28.867	-9.230	18.657	17.159	7.388	-17.732	23.296
P240C Naylors waterproof abrasive paper	0.794	0.822	128	29.338	28.010	-8.912	16.441	14.873	7.076	-17.650	25.443
P240C Naylors waterproof abrasive paper	0.790	0.722	129	29.364	28.007	-8.999	17.816	16.367	7.113	-17.813	23.488
P240C Naylors waterproof abrasive paper	0.797	0.757	130	29.412	28.062	-8.988	17.345	15.830	7.164	-17.761	24.351
P240C Naylors waterproof abrasive paper	0.816	0.796	131	28.721	27.415	-8.748	16.377	14.775	7.141	-17.698	25.794
P240C Naylors waterproof abrasive paper	0.769	0.707	132	30.390	28.965	-9.366	18.668	17.251	7.206	-17.919	22.671
P240C Naylors waterproof abrasive paper	0.792	0.704	133	28.609	27.282	-8.793	17.601	16.197	6.962	-17.864	23.259
P240C Naylors waterproof abrasive paper	0.817	0.789	134	29.140	27.803	-8.907	16.667	15.033	7.275	-17.764	25.824
P120 Cloth-backed emery paper	0.808	0.811	135	28.773	27.441	-8.846	16.106	14.469	7.146	-17.867	26.282
P120 Cloth-backed emery paper	0.802	0.770	136	28.826	27.505	-8.816	16.806	15.275	7.072	-17.773	24.841
P120 Cloth-backed emery paper	0.784	0.755	137	28.578	27.291	-8.675	17.005	15.610	6.804	-17.634	23.551
P120 Cloth-backed emery paper	0.790	0.724	138	29.366	27.992	-9.062	17.724	16.242	7.162	-17.938	23.794
P120 Cloth-backed emery paper	0.791	0.699	139	28.402	27.073	-8.777	17.494	16.087	6.945	-17.962	23.349
P120 Cloth-backed emery paper	0.793	0.680	140	28.906	27.550	-8.937	18.070	16.651	7.087	-17.972	23.056
P120 Cloth-backed emery paper	0.781	0.762	141	29.017	27.698	-8.843	17.121	15.691	6.908	-17.706	23.760
P120 Cloth-backed emery paper	0.778	0.743	142	31.595	30.140	-9.653	18.917	17.384	7.514	-17.758	23.376
P120 Cloth-backed emery paper	0.756	0.715	143	30.334	28.985	-9.132	18.821	17.527	6.901	-17.488	21.492
P120 Cloth-backed emery paper	0.782	0.690	144	30.030	28.615	-9.289	18.648	17.202	7.262	-17.985	22.888
P80 Cloth-backed emery paper	0.815	0.813	145	28.679	27.387	-8.704	16.144	14.534	7.098	-17.631	26.028
P80 Cloth-backed emery paper	0.820	0.827	146	31.430	29.959	-9.676	17.290	15.399	7.931	-17.900	27.251
P80 Cloth-backed emery paper	0.792	0.805	147	31.244	29.795	-9.578	17.665	15.984	7.583	-17.820	25.381
P80 Cloth-backed emery paper	0.795	0.829	148	29.740	28.373	-9.095	16.476	14.839	7.232	-17.774	25.984
P80 Cloth-backed emery paper	0.752	0.815	149	31.223	29.790	-9.524	17.677	16.189	7.161	-17.730	23.861

Browse | Sort by Number | Filter: Surface | Actual results

Surface 'Pace' Measurement



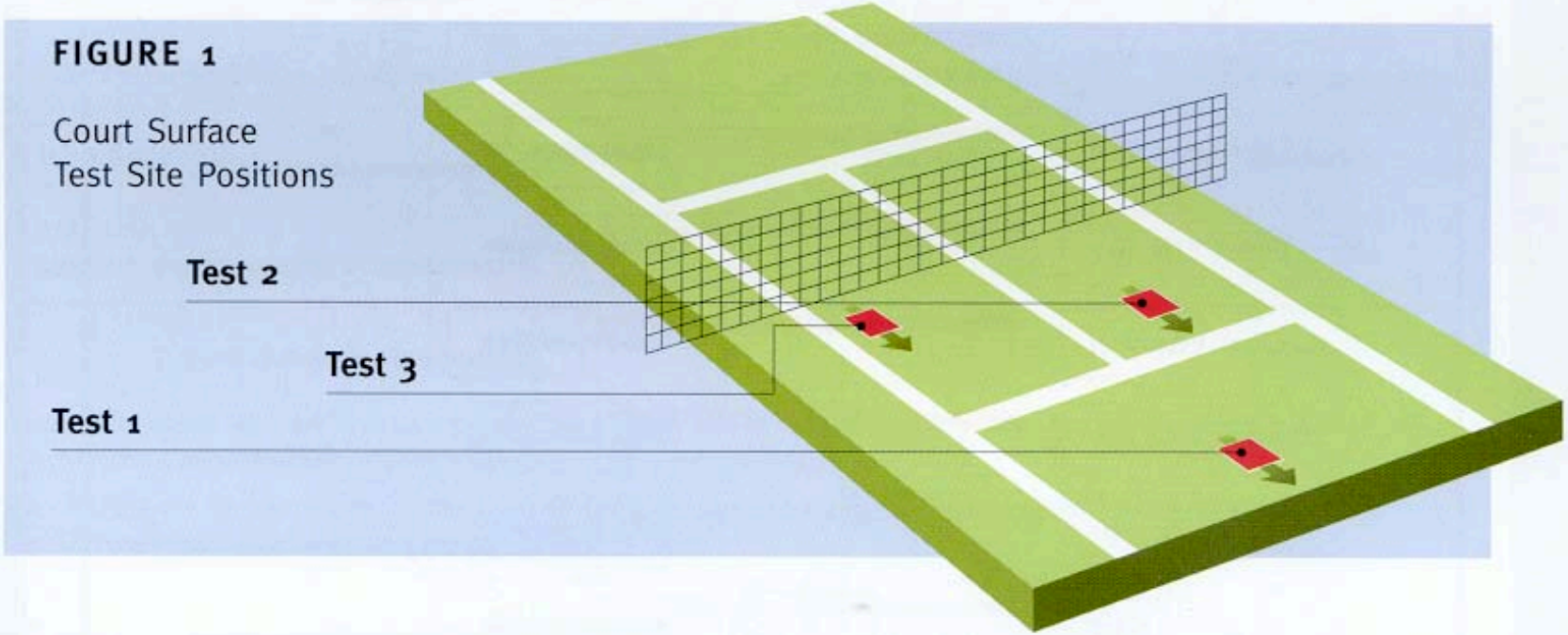
Surface 'Pace' Measurement



Surface ‘Pace’ Measurement

- **Realism**
  Use ball and court surface.
  30 ± 2 $m \cdot s^{-1}$ and 16 ± 2º.
- **Accurate**
  ± 0.005 $m \cdot s^{-1}$ and ± 0.05º.
- **Aerodynamics**
  Measurements made immediately before and after impact.

Test Protocol



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Test Report

IMPORTANT NOTE:
This report does **not** constitute ITF Surface Pace Classification as recognised in the Rules of Tennis.

Test code: ITF CS/01/01-02-009

Type of test: Laboratory

Brand name:

Test Laboratory:

Client:

Date of test:

Prepared by:
.....

Authorised by:
.....

Distribution: Copy 1 -
Copy 2 -
Copy 3 - ITF

Issue date:

Average Surface Pace Rating: XX.X

Test Report - Surface Pace : ITF CS/01/01-02-009

I

Client:

Test items:

Test date:

Full description of court surface - including manufacturer's reference, the type of supporting layers and their method of attachment:

Maunfacturers reference:

Description:

Test Procedure:

1) Tests on site shall be undertaken on a court that is less than four months old. Prior to the tests being made the courts shall be prepared using the manufacturer's, supplier's or contractor's approved procedures. The body requesting the testing shall undertake this work.

2) If the testing is undertaken in the laboratory, four samples, each measuring a minimum of 0.5m by 0.5m in area, shall be submitted to the ITF accredited laboratory. The laboratory shall select three samples at random and test each. Where the sample incorporates loose particulate materials the body requesting the tests shall prepare the samples in the laboratory.

3) Unless the surface is designed to be damp/wet when in it's optimum condition, tests shall be made with the surface in a dry condition.

4) On completion of the tests, the ITF Accredited laboratory will complete this report. One copy of the report will be sent to the body requesting the tests and one copy to the ITF. On receipt of this report the company may apply to the ITF for inclusion on the ITF list of classified tennis court surfaces.

5) When commissioning the Surface Pace assessment the company requesting the tests shall provide a detailed specification of the court/surface construction. The information will be included in this report.

6) The ITF Accredited laboratory will retain a reference sample of the surface tested as follows:

a) When the tests are carried out on synthetic surfaces the company commissioning the testing shall supply one 0.5m by 0.5m sample of the surface to the laboratory. The laboratory shall have responsibility for verifying that the surface tested on site is the same as that offered as a reference sample.

b) When the tests are carried out on clay or other water bound mineral surfaces the ITF accredited laboratory shall remove 1kg samples of the surfacing and the top 75mm of foundation material. The laboratory shall retain these materials as a reference.

c) When tests are undertaken in the laboratory one of the specimens actually tested shall be retained, as a reference.

Test Results - Surface Pace : ITF CS/01/01-02-009

Surface name:
Test date: 0

Temperature: 21ºC
Humidity: 54%

Test laboratory:
Test type: Laboratory

PACE TEST 1:

	Shot 1 (Ball 1)	Shot 2 (Ball 2)	Shot 3 (Ball 3)	Shot 4 (Ball 1)	Shot 5 (Ball 2)	Shot 6 (Ball 3)	Shot 7 (Ball 1)	Shot 8 (Ball 2)	Shot 9 (Ball 3)
Vih	28.22	29.15	29.01	28.10	27.97	28.43	27.83	28.82	29.33
Viv	8.80	8.88	8.77	8.60	8.56	9.00	8.87	9.08	9.20
Vrh	19.84	20.39	20.43	19.53	19.34	19.94	19.14	20.03	20.47
Vrv	6.58	7.24	7.07	7.08	6.75	6.67	7.13	7.04	7.17
e	0.75	0.82	0.81	0.82	0.79	0.74	0.80	0.78	0.78
f	0.54	0.54	0.54	0.55	0.56	0.54	0.54	0.55	0.54
Pace	**45.5**	**45.7**	**45.8**	**45.3**	**43.6**	**45.8**	**45.7**	**45.5**	**45.9**

PACE TEST 2:

	Shot 1 (Ball 4)	Shot 2 (Ball 5)	Shot 3 (Ball 6)	Shot 4 (Ball 4)	Shot 5 (Ball 5)	Shot 6 (Ball 6)	Shot 7 (Ball 4)	Shot 8 (Ball 5)	Shot 9 (Ball 6)
Vih	29.50	28.82	29.33	28.22	27.93	27.96	28.48	28.10	28.09
Viv	9.05	9.08	9.20	8.80	8.86	8.85	9.03	8.60	8.96
Vrh	20.43	20.03	20.47	19.84	19.23	19.20	20.15	19.53	19.57
Vrv	7.21	7.04	7.17	6.58	6.90	6.74	6.64	7.08	6.22
e	0.80	0.78	0.78	0.75	0.78	0.76	0.74	0.82	0.69
f	0.56	0.55	0.54	0.54	0.55	0.56	0.53	0.55	0.56
Pace	**44.2**	**45.5**	**45.9**	**45.5**	**44.8**	**43.8**	**46.8**	**45.3**	**43.9**

PACE TEST 3:

	Shot 1 (Ball 7)	Shot 2 (Ball 8)	Shot 3 (Ball 9)	Shot 4 (Ball 7)	Shot 5 (Ball 8)	Shot 6 (Ball 9)	Shot 7 (Ball 7)	Shot 8 (Ball 8)	Shot 9 (Ball 9)
Vih	29.32	28.34	28.36	29.51	28.54	28.06	28.49	28.22	28.10
Viv	9.23	8.97	9.00	9.45	9.16	9.04	9.12	8.80	8.60
Vrh	20.14	19.07	19.20	20.24	19.81	19.59	19.44	19.84	19.53
Vrv	7.46	7.28	7.11	6.95	6.85	6.65	7.10	6.58	7.08
e	0.81	0.81	0.79	0.74	0.75	0.74	0.78	0.75	0.82
f	0.55	0.57	0.57	0.57	0.55	0.54	0.56	0.54	0.55
Pace	**45.0**	**43.0**	**43.1**	**43.5**	**45.5**	**46.0**	**44.2**	**45.5**	**45.3**

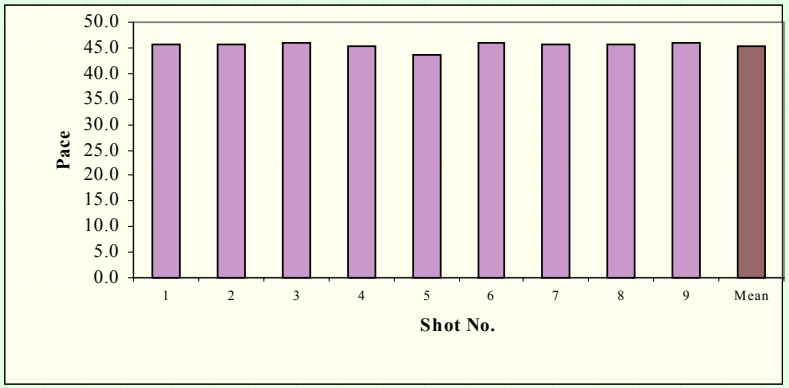
Test Summary - Surface Pace : ITF CS/01/01-02-009

Surface name:
Test date: 0

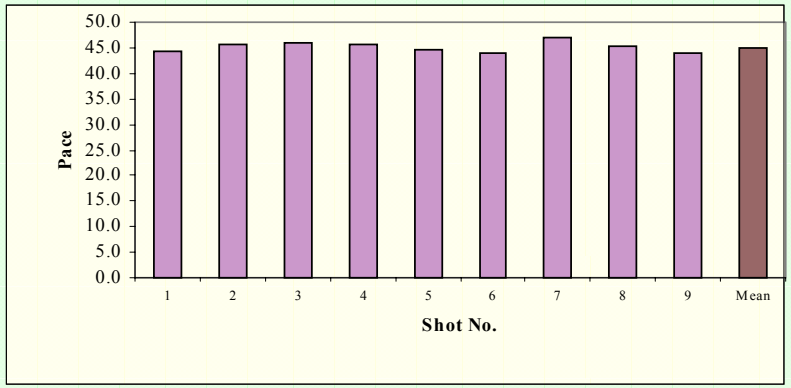
Temperature: 21ºC
Humidity: 54%

Test laboratory:
Test type: Laboratory

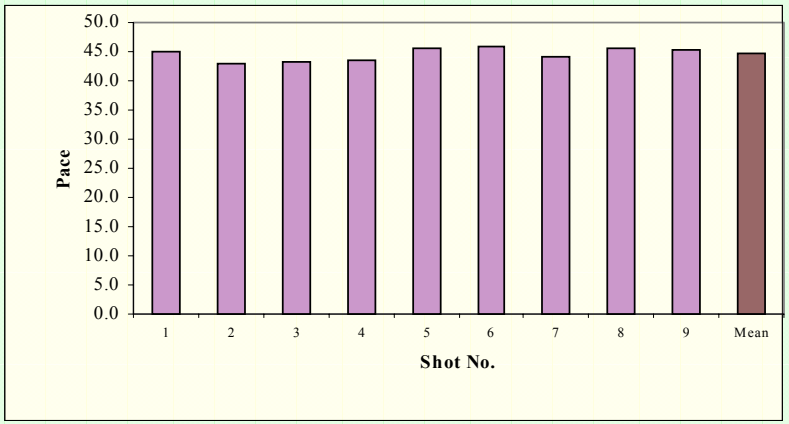
Test 1



Test 2



Test 3



Summary

Pace Test 1	45.4
Pace Test 2	45.1
Pace Test 3	44.6
Average e	0.78
Average f	0.55
Average Surface Pace	**45.0**
Standard Deviation	**0.4**

ITF Criteria: Slow - (0 - 35) Medium / Medium Fast - (30 - 45) Fast - (40+)

Test Report - Surface Pace : ITF CS/01/01-02-009

Surface name:
Test date: ##########

Temperature: 21ºC
Humidity: 54%

Test laboratory:
Test type: Laboratory

Laboratory Comments:

Although the tests were carried out on laboratory samples the appearance and finish of the test specimens was considered to be representative of the surface when laid on a tennis court.

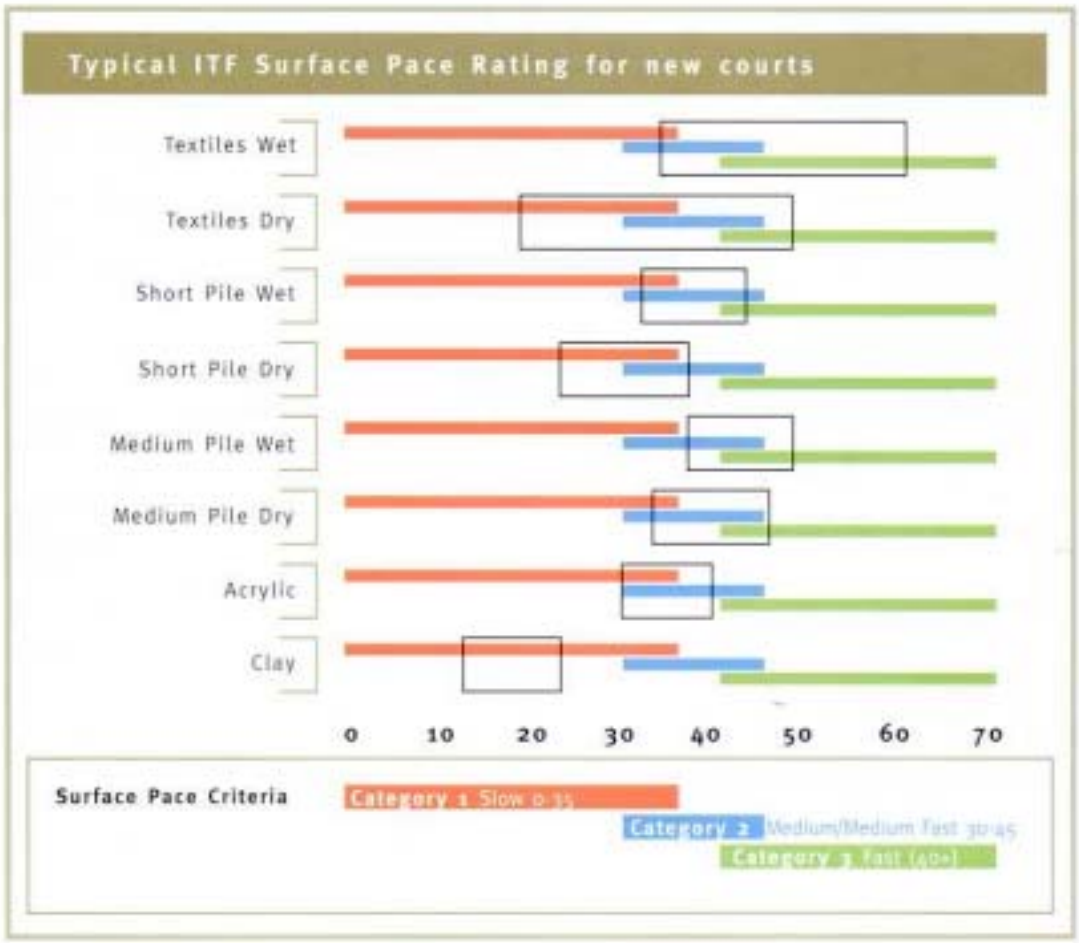
_____ defines a tennis court surface as the top (playing) surface and any underlying layers of construction that influence the sports performance (or bio-mechanical) response of a court. If any elements of the surface's construction change the response, performance and classification of the surface may be different. As such the results detailed in this report only apply to the surface when laid on a rigid (concrete, asphalt, etc.) base.

Laboratory Recommendations:

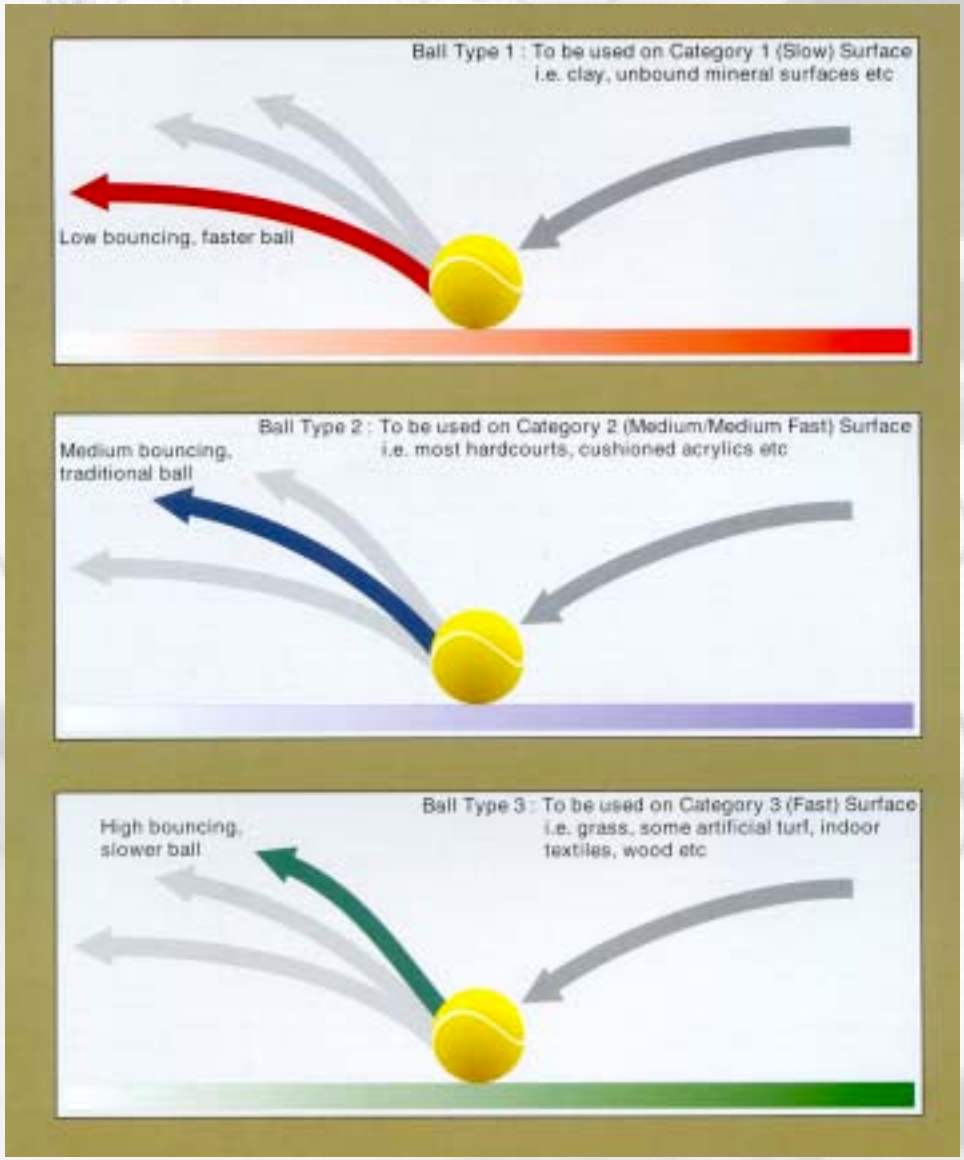
The results detailed in this report are considered to be a valid assessment of the Surface Pace characteristics of the product. In _____ opinion the product satisfies the technical criteria required of tennis court surfaces wishing to appear in the ITF's Court Surface Classification Scheme. CST recommend, subject to ITF approval, that _____ is included on the list of classified surfaces.

Surface Pace Classification

Typical Pace Ratings



Surface and Ball Types



Related Publications

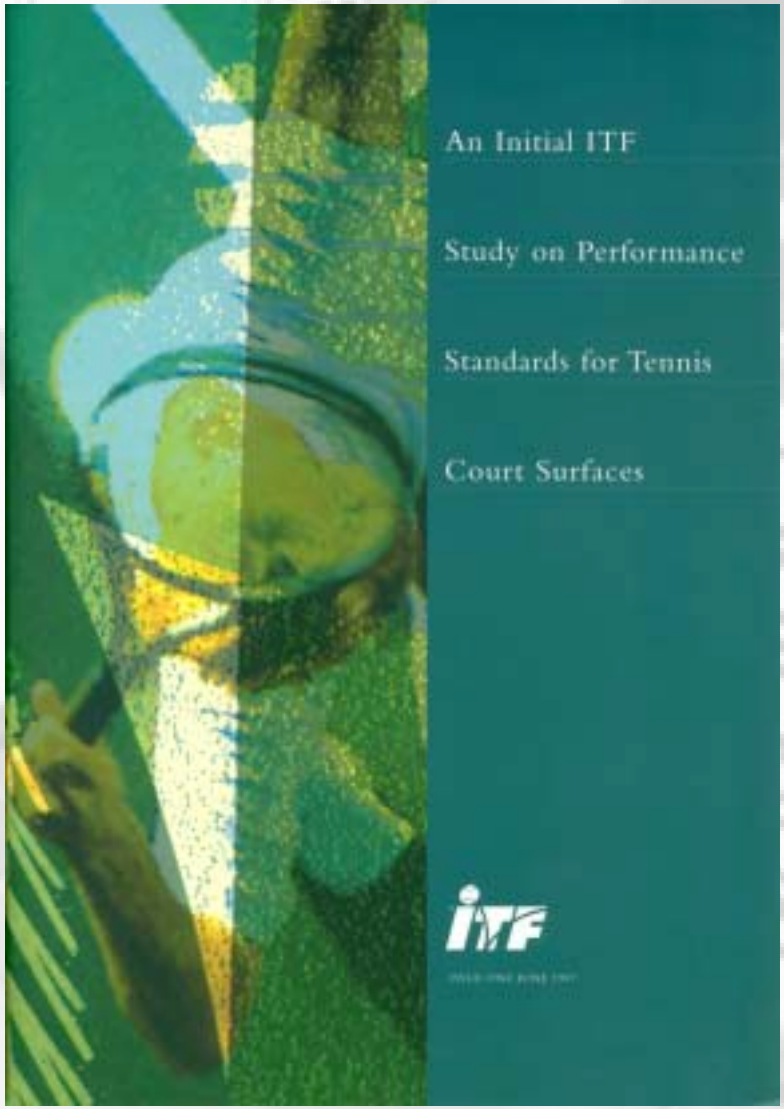
General Issues

- Not an approval scheme (e.g. safety).
- Currently have 28 classified surfaces (number increasing).
- Classification is immediate following receipt of application form, test report and payment.
- Classification valid for 3 years.

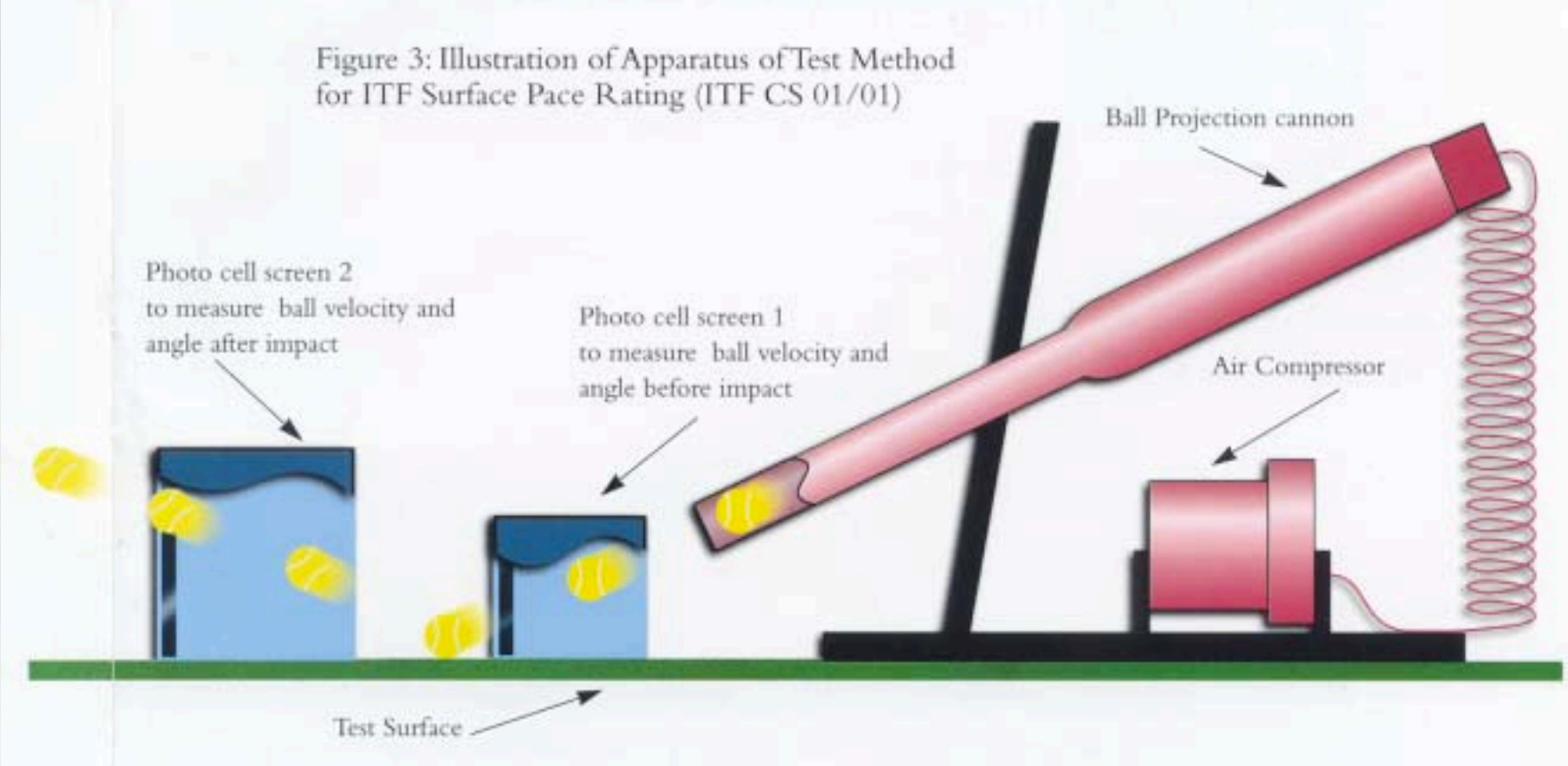
Costs

Classification Fee	Non-Foundation members	Supporting level & Sponsoring level Foundation members	General level Foundation members
1st submission	US$2500	US$1500	US$2000
2nd and subsequent submissions	US$1500	US$900	US$1000

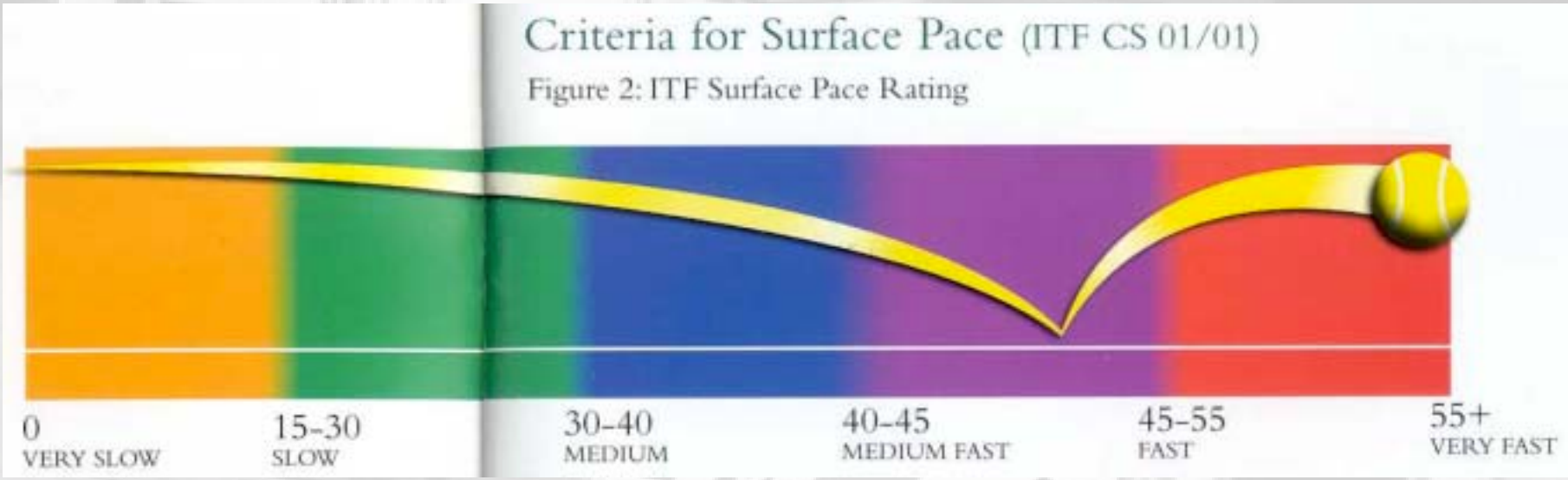
Related Publications



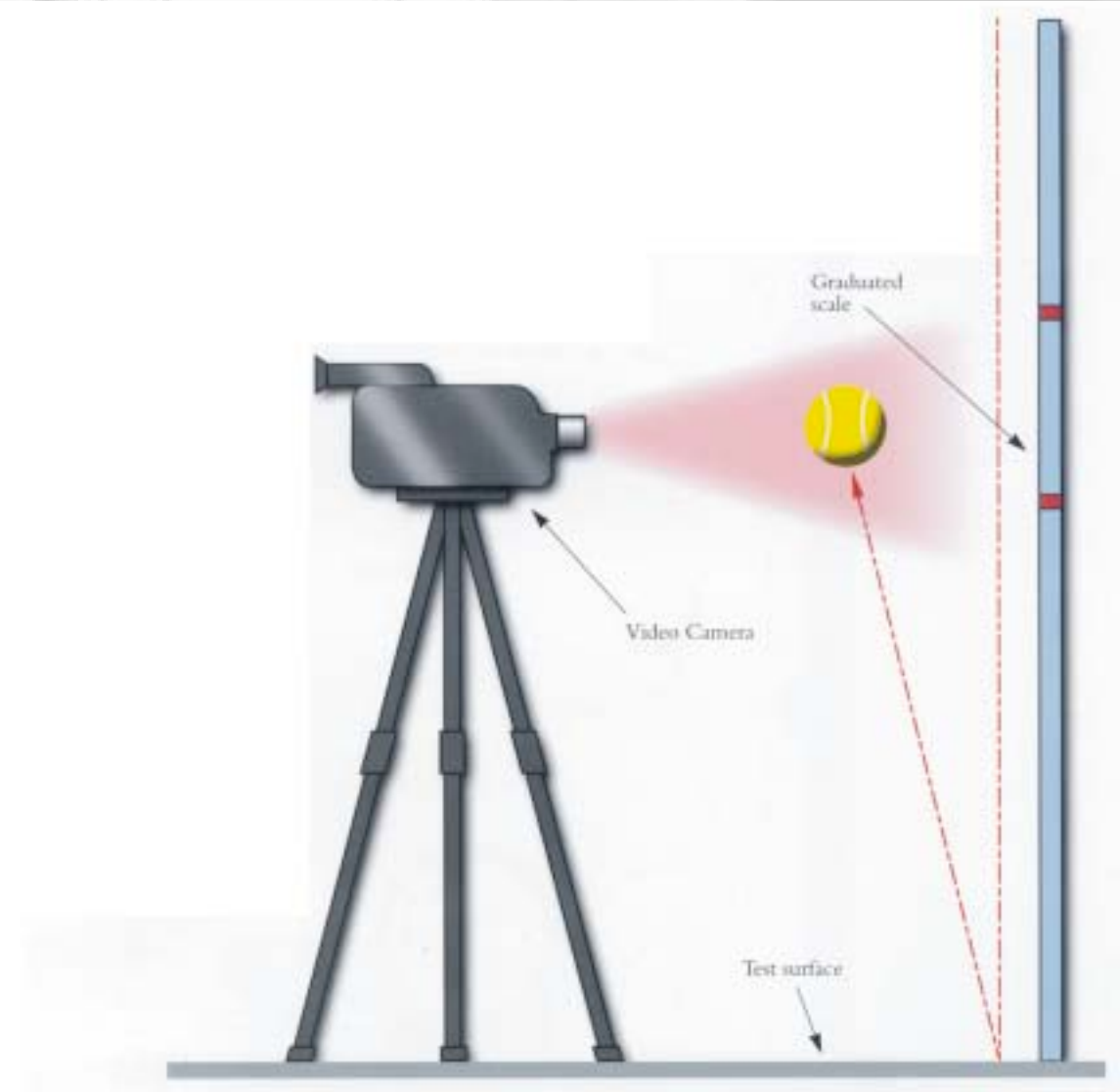
Surface Pace Test



Surface Pace Test



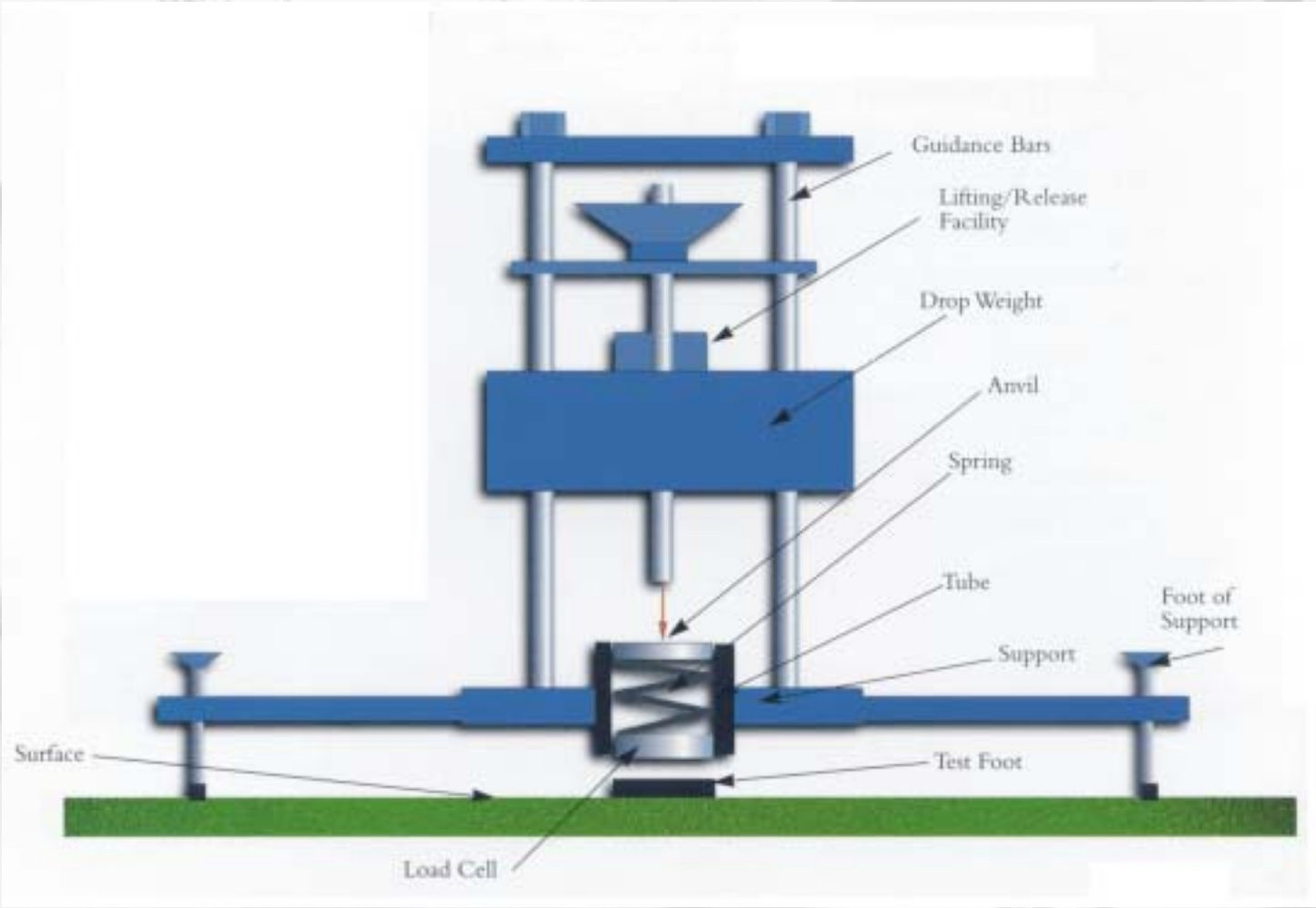
Other Tests



Other Tests

Figure 11: Classification of Vertical Ball Rebound

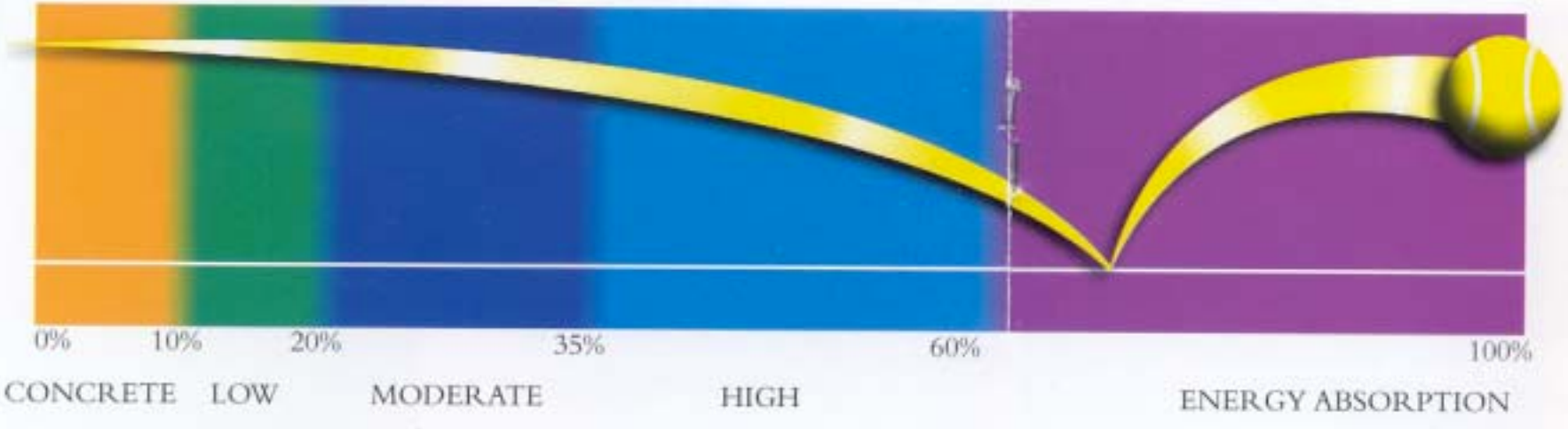
Other Tests


Guidance Bars
Lifting/Release Facility
Drop Weight
Anvil
Spring
Tube
Foot of Support
Support
Surface
Test Foot
Load Cell

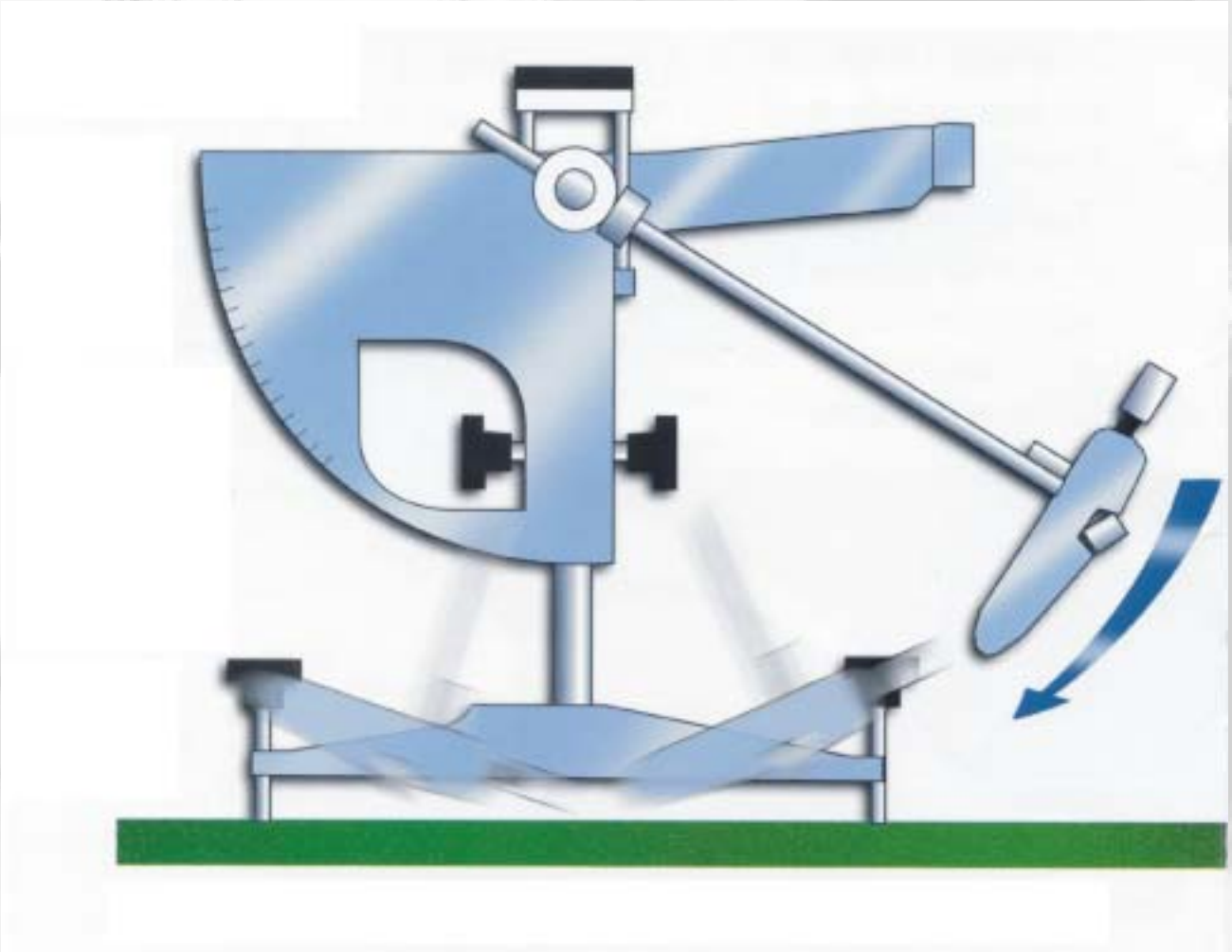
Other Tests

Criteria for Shock Absorption (ITF CS 04/01)

Figure 9: Initial Criteria for Shock Absorption of tennis court surfaces.



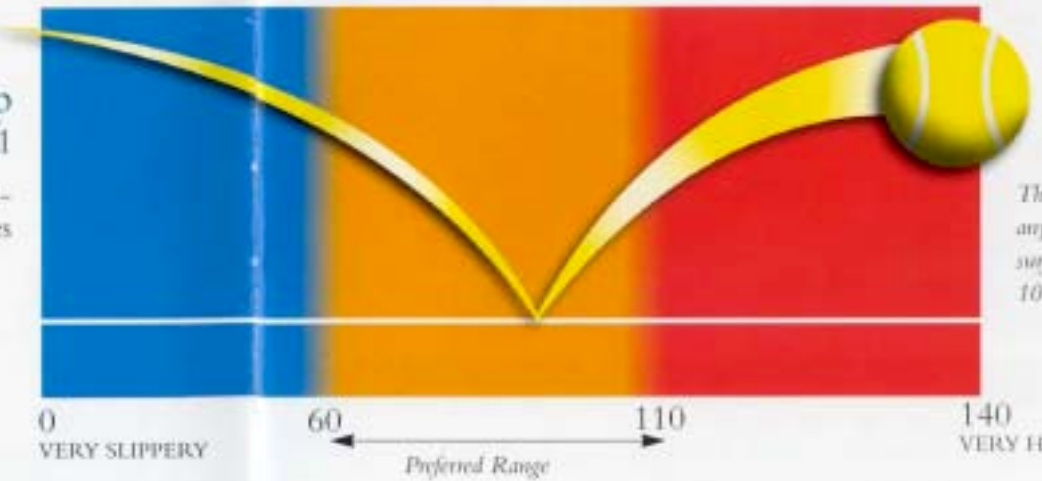
Other Tests



Other Tests

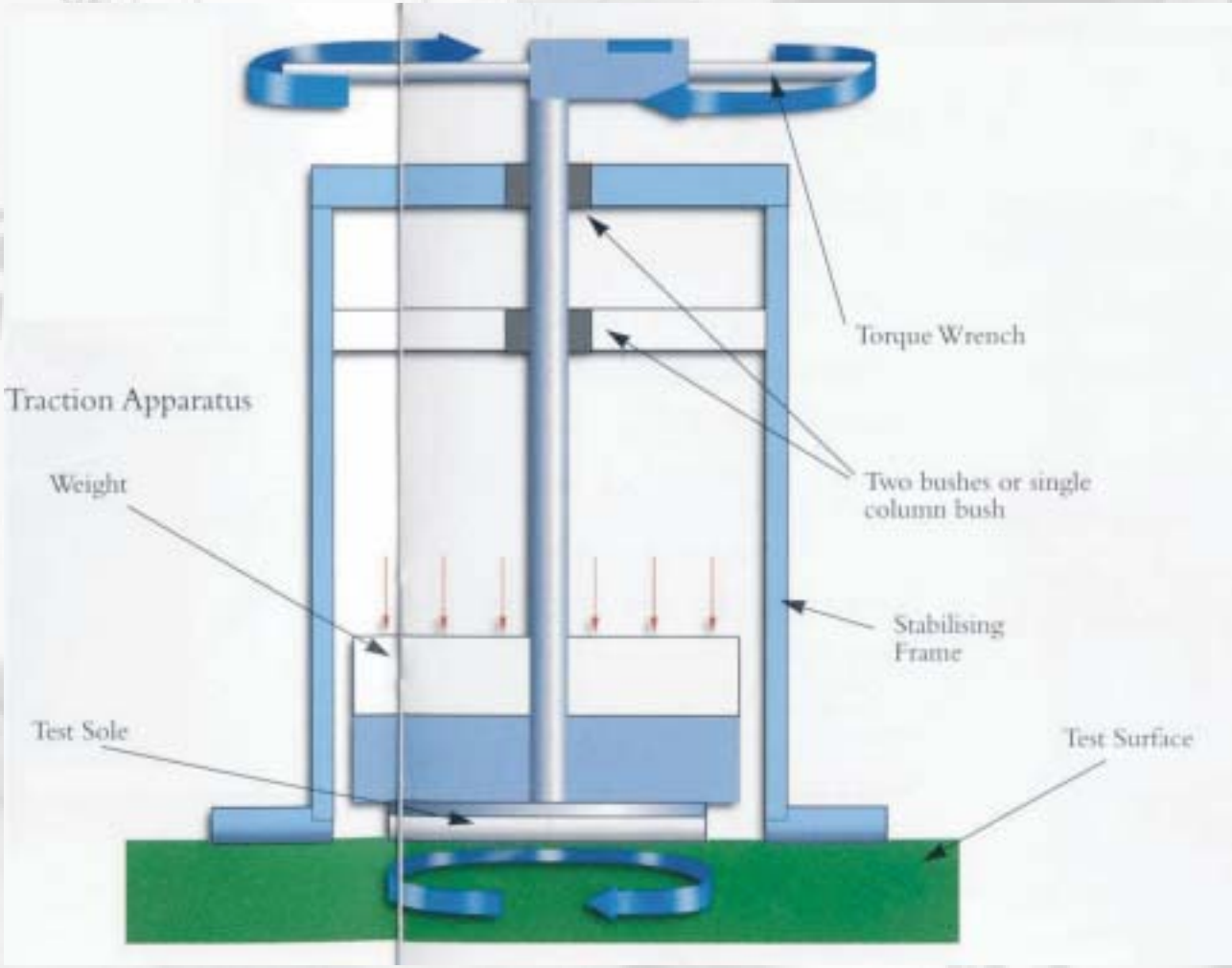
Criteria for Slip Resistance ITF CS 02/01

Figure 5: Preferred Range for non-sliding Tennis Surfaces



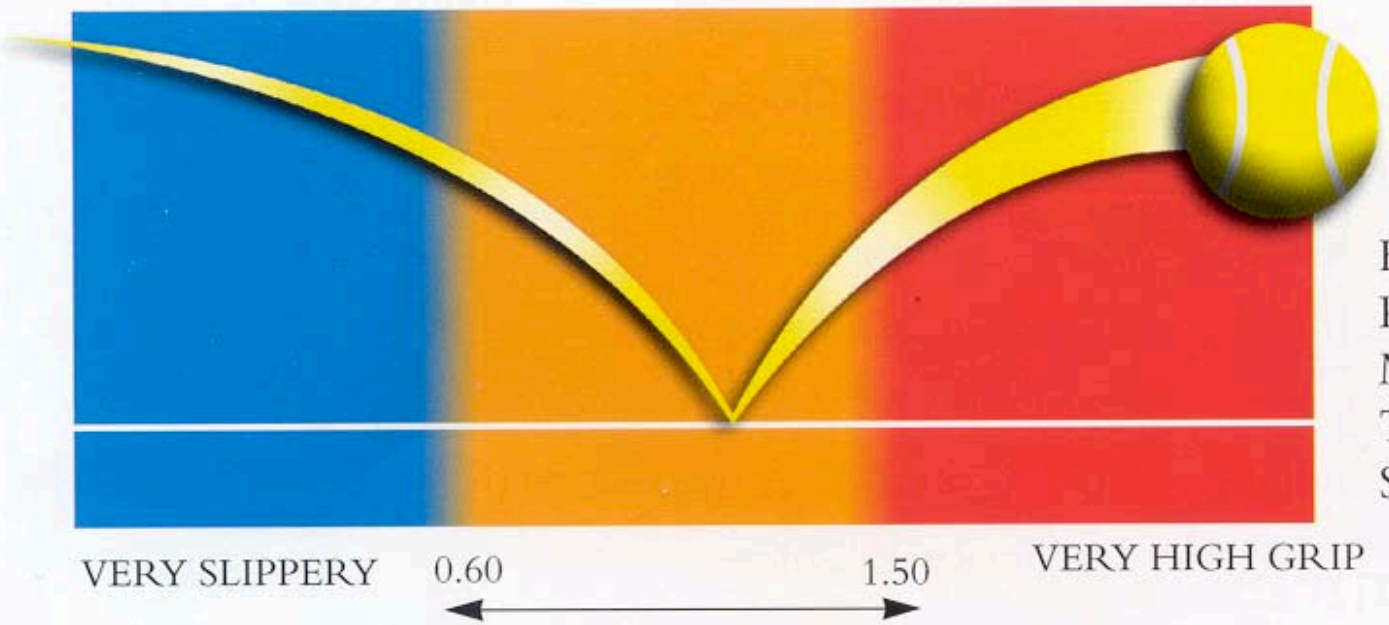
The maximum variation in value due to any directional pattern, (eg: in textile surfaces) should preferably be less than 10%.

Other Tests


Traction Apparatus
Weight
Torque Wrench
Two bushes or single column bush
Stabilising Frame
Test Sole
Test Surface

Other Tests

Criteria for Traction (ITF CS 03/01)



Preferred Range for non-sliding Tennis Court surfaces

Figure 7: Preferred Range for Traction Measurements on Tennis Court Surfaces

Other Tests

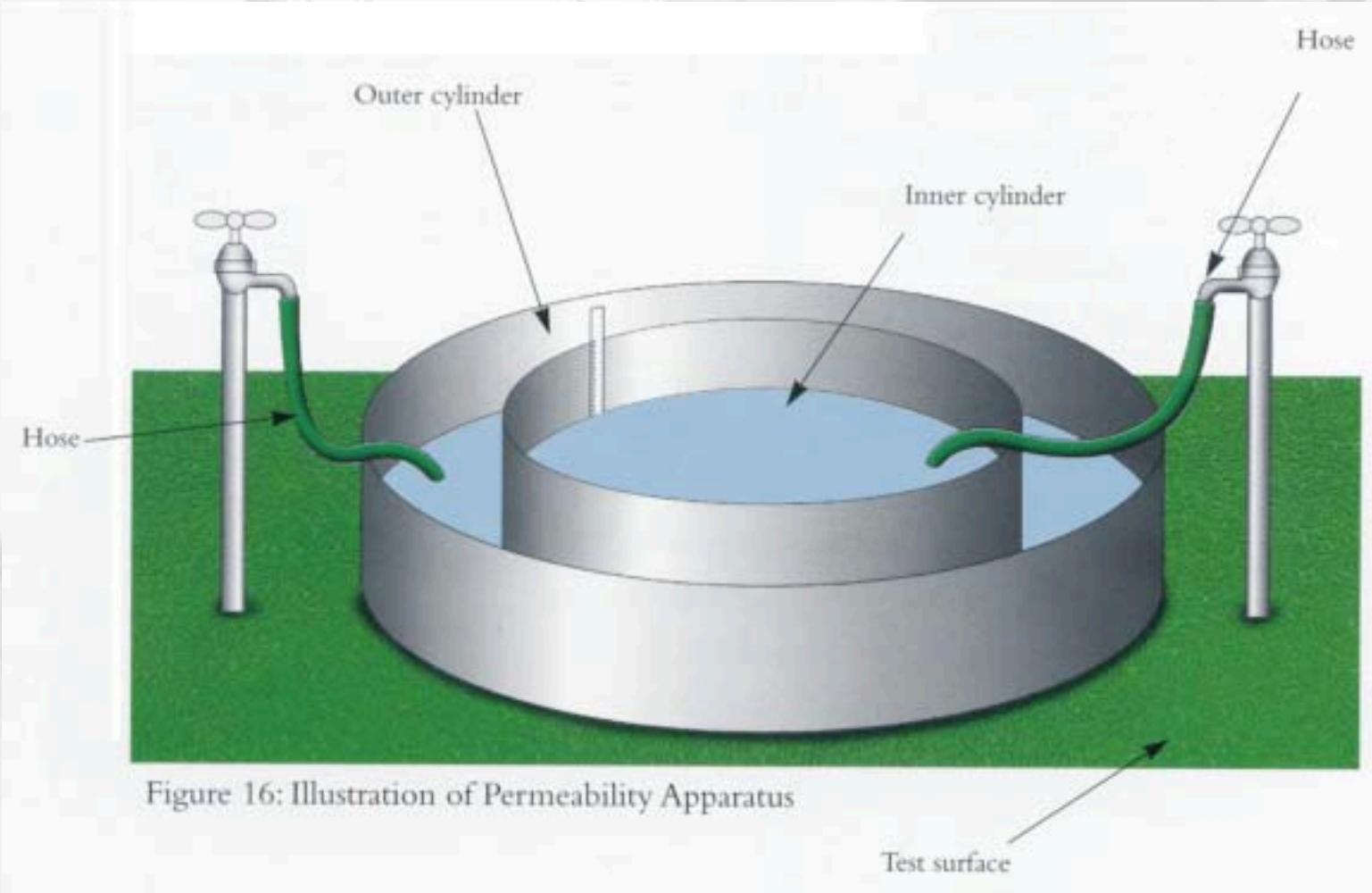
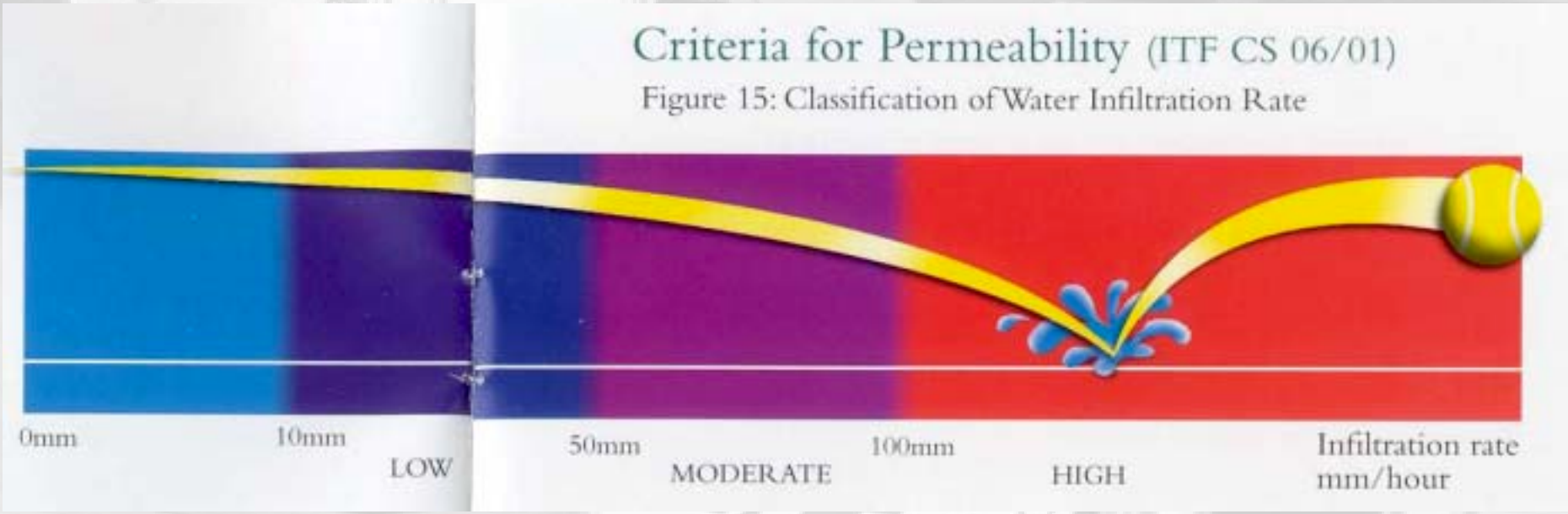
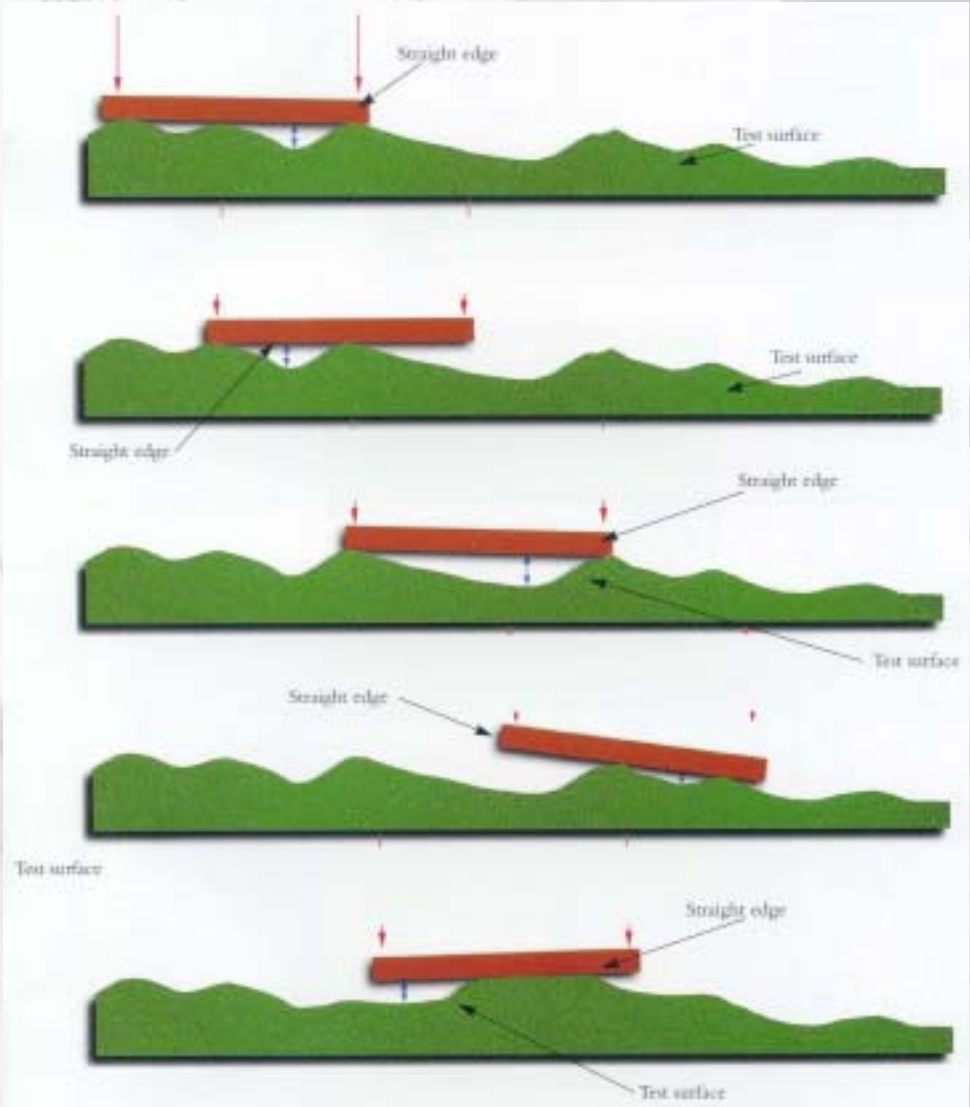


Figure 16: Illustration of Permeability Apparatus

Other Tests


Criteria for Permeability (ITF CS 06/01)
Figure 15: Classification of Water Infiltration Rate
0mm
10mm
LOW
50mm
MODERATE
100mm
HIGH
Infiltration rate
mm/hour

Other Tests


Straight edge
Test surface
Test surface
Straight edge
Straight edge
Test surface
Straight edge
Test surface
Straight edge
Test surface

Other Tests

Laboratory Accreditation

Criteria

- Adequate equipment and facilities.
- Quality assurance.
- Experience in sports surfaces.
- Independence.
- ISSS member.

Laboratory Accreditation

Procedure

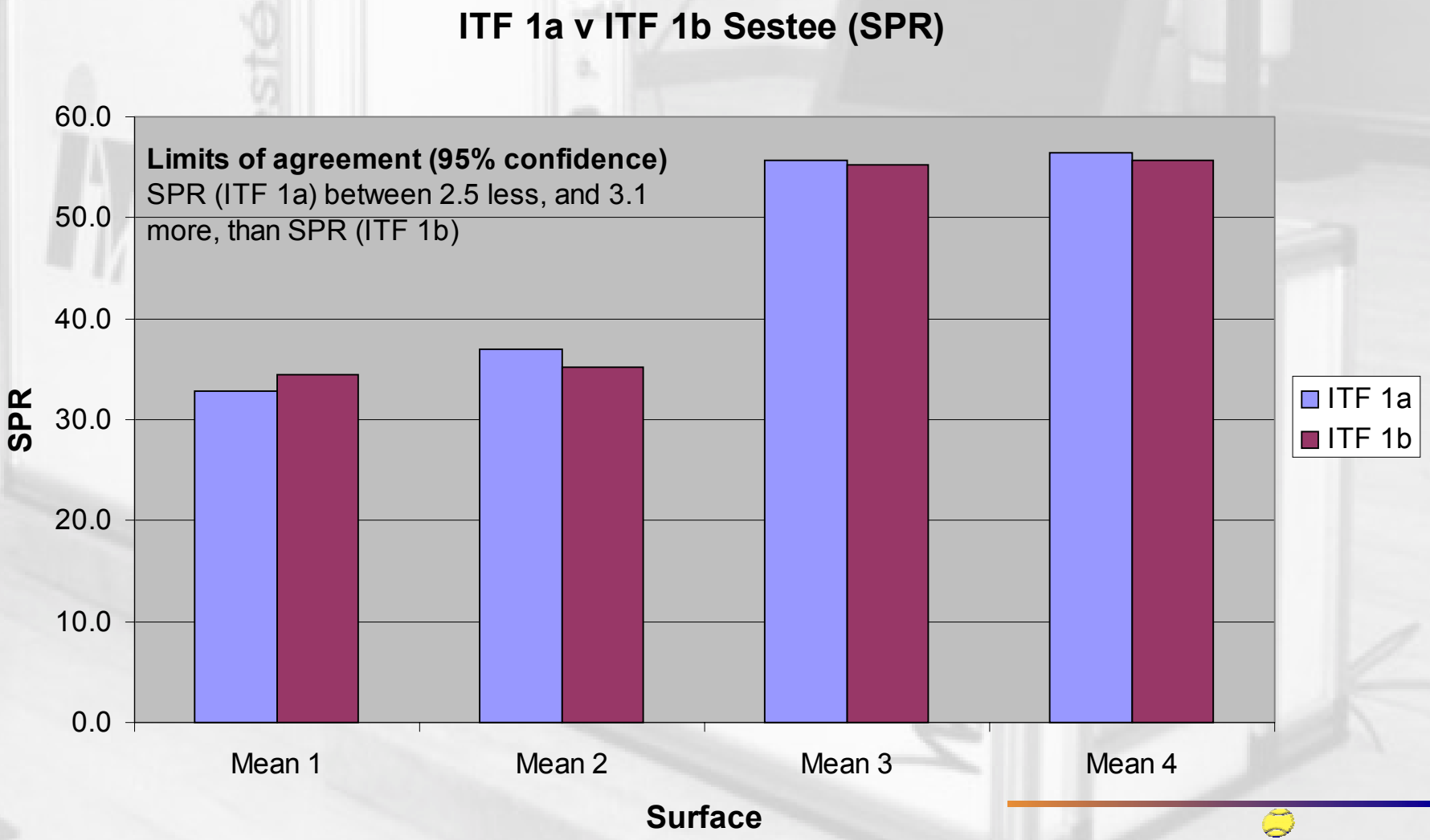
- Letter of application:
  - List of equipment.
  - Organisational structure and staff CVs.
  - Details of experience.
  - List of publications.
  - Membership of professional organisations.

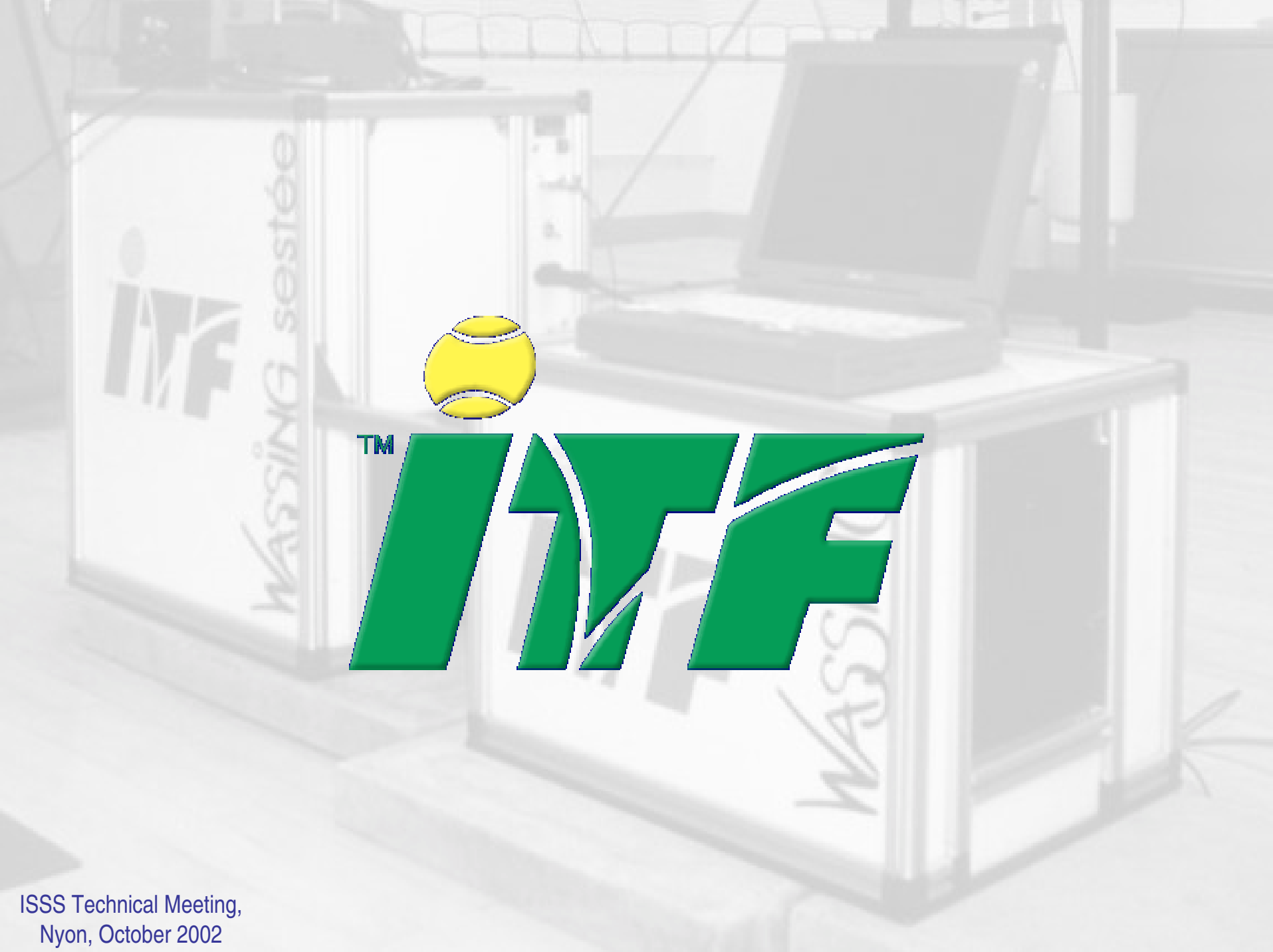
Laboratory Accreditation

Procedure

- Validation of equipment.
- Support of 2 ITF Accredited Laboratories and National Tennis Association.
- Inspection by Accredited person.

Laboratory Accreditation





ISSS Technical Meeting,
Nyon, October 2002