FIG International Gymnastics Federation

IV Testing Procedures

Contents:

Chapter IV comprises the detailed technical descriptions of the test procedures for those gymnastics' apparatus for which a test at an official FIG test laboratory is obligatory. For identification of apparatus the same abbreviations as in chapter II are used.
Since the following explanations are primarily intended for FIG authorities, technicians, engineers and sports scientists, as well as for test laboratories and research departments of companies, they are published in English exclusively.

FIG International Gymnastics Federation
Overview of the gymnastic apparatus with obligatory Tests at FIG Test - Institutes

MAG	Apparatus	Code	Date of Issue	Equivalence
	Floor	MAG1	01.01.2016	WAG4; ACRO1
	Pommel Horse	MAG2	01.12.1994	
	Rings	MAG3	1989	
	Vaulting Table	MAG4	01.02.2001	WAG1
	Parallel Bars	MAG5	11.05.2010	
	High Bar	MAG6	11.05.2010	
	Landing Mat 20cm	MAG11	01.08.1996	WAG11; ACRO11
	Landing Mat 10cm	MAG12	12.07.1989	
	Vaulting Board	MAG14	01.01.2006	WAG14; TRA15
	TCS	MAG18	01.09.2019	WAG18
	Apparatus Control Forms (Type B)	MAG	01.01.2016	

WAG	Apparatus	Code	Date of Issue	Equivalence
	Vaulting Table	WAG1	01.02.2001	MAG4
	Uneven Bars	WAG2	15.03.2023	
	Balance Beam	WAG3	01.12.1994	
	Floor	WAG4	01.01.2016	MAG1; ACRO1
	Landing Mat 20cm	WAG11	01.08.1996	MAG11; ACRO11
	Vaulting Board	WAG14	01.01.2006	MAG14; TRA15
	TCS	WAG18	01.09.2019	MAG18
	Apparatus Control Forms (Type B)	WAG	01.01.2016	

RG	Apparatus	Code	Date of Issue	Equivalence
	Floor	RG1	01.12.1992	
	Apparatus Control Forms (Type B)	RG	01.01.2016	

FIG International Gymnastics Federation
Overview of the gymnastic apparatus with obligatory Tests at FIG Test - Institutes

TRA	Apparatus	Code	Date of Issue	Equivalence
	Trampoline	TRA1	01.01.2016	
	Tumbling Track	TRA3	01.07.1996	
	Vaulting Board	TRA14	01.01.2006	MAG14; WAG14
	Time measurement Devices for Trampoline Competitions, TMD	TRA15	1.1.2020	
	Horizontal displacement measurement Devices for Trampoline Competitions, HDMD	TRA16	1.6.2018	
	Landing Mat 30cm	TRA17	01.05.2021	

ACRO	Apparatus	Code	Date of Issue	Equivalence
	Floor	ACRO1	01.01.2016	MAG1; WAG4
	Landing Mat 20cm	ACRO11	01.01.2000	MAG11; WAG11

AER	Apparatus	Code	Date of Issue	Equivalence
	Floor	AER1	01.01.2016	

PK	Apparatus	Code	Date of Issue	Equivalence
	Obstacles and Scaffolding	PK	01.03.2020	

Standard Specification: Floors for Men Artistic Gymnastics

This standard is issued under the fixed designation FIG: IV-MAG1-01.01.2016; the numbers immediately following the designation indicate the date of original adoption by the FIG, or, in case of revision, the date of the last revision. This FIG standard was prepared by the Apparatus Commission of the FIG and participating FIG test laboratories. This standard was originally published in English only.

Introduction

The objective of this FIG standard is to provide equal opportunities for all athletes in FIG competitions by controlling the functional properties of floors and to minimize any differences between competition and training equipment.

1 Scope

1.1 This specification covers the measurement of certain shock-absorbing characteristics, the impact force - time relationships, and the rebound properties of gymnastic floors. This standard specification is applicable to all gymnastic floors that are to be used at any FIG-sanctioned event.

1.2 This specification does not imply that an injury cannot be incurred while using a gymnastic floor which complies with this specification.

1.3 The test procedures associated with this standard may involve hazardous operations and equipment. This standard does not purport to address all the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to use.

2 Normative References

2.1 Society of Automotive Engineers: SAE J211 Recommended Practice for Instrumentation for Impact Tests – Requirements for Channel Class 1000, October 1988.

2.2 International Gymnastics Federation (FIG): Apparatus Rules: II-MAG1.

3 Terminology

3.1 *Description of terms specific to this standard:*

3.1.1 *Acceleration:* The instantaneous time rate of change of velocity, expressed in m/s^2, which may be positive or negative.

3.1.2 *Base plane:* The starting reference plane of the gymnastic floor from which the total deflection and total height of rebound is determined. It is taken as the top plane of the gymnastic floor.

3.1.3 *Performance area:* Complete construction of the gymnastics floor as intended to be used according to the specifications in FIG Apparatus Norms Part II, MAG 1, WAG4 and performance area (12 * 12 m)

3.1.4 *The Test specimen:* Shall be a part of the complete performance area (12 * 12 m) according to Figure 1

3.1.5 *Measurement area:* A specific area of 3 * 2m on the test specimen with absolute defined measurement points for impact tests.

3.1.6 *Deflection:* The measured distance (in mm) between the base plane and the maximum displacement of the impactor below the base plane.

3.1.7 *Force (F):* The product of the mass of the impactor, expressed in kg, and the acceleration of the impactor, expressed in m/s^2.

3.1.8 *Maximum Force (F_{max}):* The maximum value of force measured during the impact and expressed in Newtons.

3.1.9 *Height of rebound:* The measured distance (in mm) between the base plane and the maximum displacement of the impactor above the base plane.

3.1.10 *Impactor:* The striking part of the test apparatus.

3.1.11 *Impact velocity:* The velocity of the impactor, expressed in m/s, immediately prior to crossing the base plane on impact.

3.1.12 *Theoretical drop height:* A calculated drop height which equates the measured velocity of the impactor at the moment of impact to a height that would generate the same velocity if the test were performed at sea level and there was no friction to retard the impactor during a drop from that height.

4 Principle of Measurement

4.1 A test specimen is impacted at a specified velocity with an impactor of given mass and geometry. A transducer mounted in the impactor monitors the acceleration – time history of the impactor which is recorded with the aid of a data acquisition system. An additional transducer may be used to monitor the displacement – time history of the impactor.

4.2 Dynamic data obtained during these procedures are indicative of the cushioning and rebound properties of the gymnastic floor and materials used in training and FIG-sanctioned competitions.

5 Performance Requirements

5.1 When tested according to the procedures described in Section 9, the overall mean values of the measured variables across all impact sites shall be within the figures of Table 1.

Table 1: Figures for Gymnastic Floors

x represents the mean value of the measured variable

Deflection (mm)	***Height of rebound***	***F_{max} (N)***
$x \leq 75$	$245 \leq x \leq 335$	$x \leq 3900$

6 Test Apparatus

6.1 *Impact test machine:* Any type of dynamic testing apparatus that is capable of impacting a test specimen at a prescribed impact velocity and monitoring and recording the acceleration - time history of the impactor is acceptable. The impact test machine and the impactor shall have sufficient rigidity to eliminate undesirable vibrations in the apparatus which might be recorded on the acceleration - time curve. The impact test machine shall also be designed in such a manner that only the impact face contacts the test specimen at any time during the test procedures.

6.2 *Impactor:* The impactor shall be 20 kg ± 0.2 kg and shall have a flat impact face with a 10 cm ± 0.5 cm diameter. The edge of the impactor face should be relieved to eliminate sharp edges. Provision shall be made so that the accelerometer can be securely fastened parallel to the vertical axis of the impactor with a maximum deviation of ± 5º.

6.3 *Recording equipment - The recording equipment shall meet the following criteria:*

6.3.1 *Acceleration - time:* The selection of the specific acceleration - time recording equipment, including transducers and recorders, is at the discretion of the test laboratory. However, the recording system shall have a frequency response adequate to measure the peak acceleration value to an accuracy of ± 5% of the true value. The total system, detection and recording, shall be capable of measuring impact accelerations of up to 200 g at frequencies from 2 to 1000 Hz to an accuracy of ± 5%. The minimum sampling rate of the data acquisition system shall be 5000 Hz.

6.3.2 *Displacement - time:* It is optional, but desirable, that the displacement - time history is recorded by a separate transducer. Any transducer that provides a linear signal proportional to the displacement of the impactor along the impact axis which can be monitored simultaneously with the acceleration - time trace is acceptable. If displacement is recorded, the test equipment shall have means to determine and record the top plane (base plane) of the test specimen from which the total deformation and rebound height are determined.

6.3.3 *Filtering:* The signal from all transducers shall be conditioned with a low pass filter which complies with Channel Class 1000 of SAE Recommended Practice J211. A fourth-order Butterworth low pass filter with a cut-off frequency of 1000 Hz meets this requirement.

7 Test Specimen

7.1 The test specimen submitted for testing shall represent the gymnastic floor as it is intended to be used during training and/or competition.

7.2 The test specimen shall comply with FIG Apparatus Rules: II-MAG1. Exception: See 7.3.

7.3 The horizontal dimensions (length * width) for any test specimen shall be 3 * 2 m as a minimum.

7.3.1. The test specimen shall be a part of the complete performance area (12 * 12 m) (see Figure 1).

7.3.2. The sides of the test specimen shall be parallel to the orientation of the plates in the performance area.

7.3.3. The test specimen shall consist of a minimum number of full compartments (uncut plates) that completely span over a measurement area of 3 * 2 m.

7.3.4. There shall be a junction of at three plates of the under-construction exactly in the middle of the test specimen (see Figure 1). In case of multiple layers, the first layer of plates from the bottom side has to be taken as the reference for the orientation of the plates.

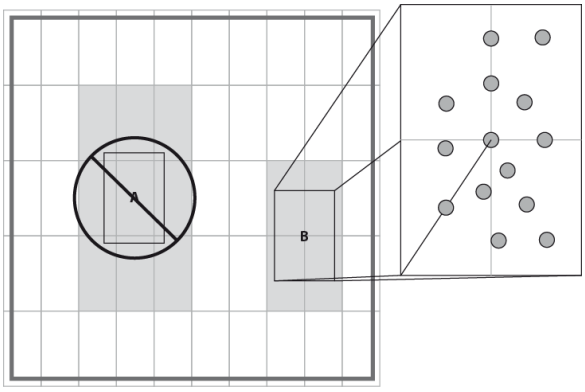
7.3.5. The test specimen shall not comprise reinforcement parts of the edge of the performance area.

7.3.6. The fixations between the elements of the test specimen shall be as similar as possible to the fixations of the whole performance area.

7.3.7. The test specimen shall come with an engineering drawing of the complete floor construction and the identification of the plates of the test specimen.

7.3.8. There always has to be contact with the test institute about the test specimen and the information about the construction and position of the test specimen in the complete floor. Not doing so can lead to a longer testing period or even to a refusal of the test specimen

Figure 1: Examples for a *test specimen* (grey) and the corresponding *measurement area* out of the complete Gymnastic Floor. "A" is not correct, "B" is correct.



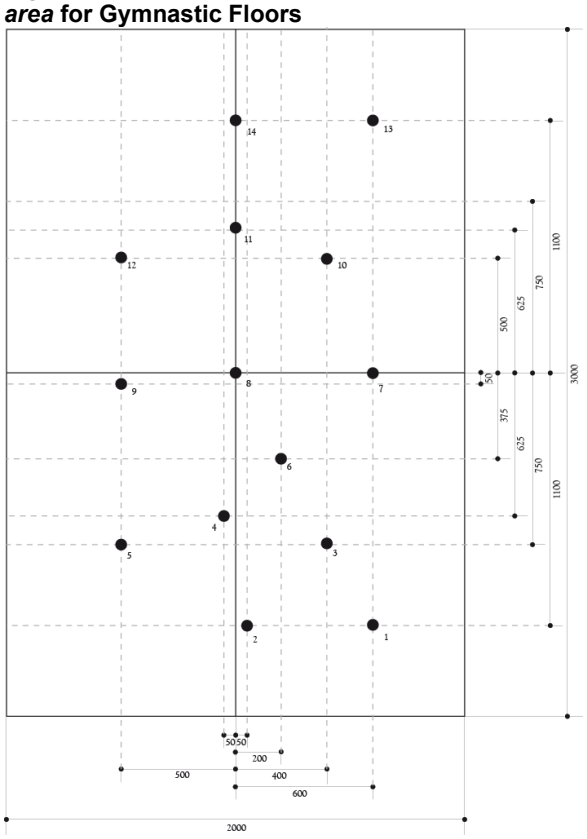
8 Conditioning and Test Temperature

8.1 Test specimens shall be preconditioned at 50% ± 10% relative humidity and 21º C ± 3º C for a minimum of 24 hours prior to the test. All testing shall be carried out under the same conditions.

9 Laboratory Procedure (Test Method)

9.1 *Impact locations:* A total of fourteen impact sites shall be designated on the test specimen. See Figure 2 for an illustration of the impact sites

Figure 2: Impact Locations on the *measurement area* for Gymnastic Floors



9.2 *Impact test procedures:*

9.2.1 Place the test specimen under the impact test machine on a smooth, solid floor (concrete or metal plate) and orient the impactor such that the centre of the impact face will contact one of the designated impact test sites.

9.2.2 Raise the impactor to an appropriate drop height such that it will contact the test specimen with an impact velocity of 3.96 m/s ± 3%. This corresponds to a theoretical drop height of 0.8 m.

9.2.3 Release the impactor and capture the acceleration - time history and displacement - time history (if applicable) using recording equipment described in Section 6.3.

9.2.4 Upon completion of a given impact test, raise the impactor off the surface of the test specimen.

9.2.5 The duration between tests at a given impact site shall not be less than 30 seconds.

9.2.6 Each test specimen shall receive a total of 140 impacts. Impact each of the fourteen impact sites ten times.

9.3 *Calculations:*

9.3.1 Immediately following each test, record the following measurements: F_{max} (N), Deflection (mm) and Height of Rebound (mm).

9.3.2 The last eight tests for each impact site shall be used to determine the arithmetic mean value of a measured variable for each impact site and for the overall mean value of a measured variable across all impact sites.

9.3.3 Calculate the mean values of Deflection, Height of rebound and F_{max} across all impact sites rounded to zero decimal places.

10 Report

10.1 *The test report shall include the following information:*

10.1.1 Complete identification of the tested gymnastic floor, including type, source, manufacturer's model number (if appropriate), dimensions of test specimen, and any other pertinent information. Photographs may be included in the test report for sample documentation purposes.

10.1.2 Test identification number according to the internal regulations between the FIG Test Institutes.

10.1.3 Complete identification of the testing laboratory including test technician and test laboratory manager (if appropriate).

10.1.4 Conditions of test, including test date, temperature and humidity.

10.1.5 Description of the impactor mass and the drop height conditions.

10.1.6 Description of the test results relative to the performance requirements identified in Section 5.

10.1.7 The test specimen shall come with an engineering drawing of the complete floor construction and the identification mark of the plates of the test specimen.

10.1.8 Mean values of Deflection, Height of rebound and F_{max} across all impact sites.

10.1.9 Maximum value, minimum value and standard deviation of Deflection, Height of rebound and F_{max} variables.

10.1.10 Mean values of Deflection, Height of rebound and F_{max} for the last eight tests at each impact site.

10.1.11 Deflection, Height of rebound and F_{max} values for all tests.

Standard Specification: Pommel Horses for Men Artistic Gymnastics

This standard is issued under the fixed designation FIG: IV-MAG2-01.12.1994; the numbers immediately following the designation indicate the date of original adoption by the FIG, or, in case of revision, the date of the last revision. This FIG standard was prepared by the Apparatus Commission of the FIG and participating FIG test laboratories. This standard was originally published in English only.

Introduction

The objective of this FIG standard is to provide equal opportunities for all athletes in FIG competitions by controlling the functional properties of pommel horses and to minimize any differences between competition and training equipment.

11 Scope

11.1 This specification covers the measurement of certain shock-absorbing and frictional characteristics of pommel horse bodies, as well as positional stability and frictional characteristics of pommels. This standard specification is applicable to all pommel horses that are to be used at any FIG-sanctioned event.

11.2 This specification does not imply that an injury cannot be incurred while using a pommel horse which complies with this specification.

11.3 The test procedures associated with this standard may involve hazardous operations and equipment. This standard does not purport to address all the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to use.

12 Normative References

12.1 Society of Automotive Engineers: SAE J211 Recommended Practice for Instrumentation for Impact Tests – Requirements for Channel Class 1000, October 1988.

12.2 International Gymnastics Federation (FIG): Apparatus Rules: II-MAG2.

13 Terminology

13.1 *Description of terms specific to this standard:*

13.1.1 *Acceleration:* The instantaneous time rate of change of velocity, expressed in m/s^2, which may be positive or negative.

13.1.2 *Base plane:* The starting reference plane of the horse body from which the total deflection and total height of rebound is determined. It is taken as the top plane of the horse body.

13.1.3 *Deflection:* The measured distance (in mm) between the base plane and the maximum displacement of the impactor below the base plane.

13.1.4 *Force (F):* The product of the mass of the impactor, expressed in kg, and the acceleration of the impactor, expressed in m/s^2.

13.1.5 *Maximum Force (F_{max}):* The maximum value of force measured during the impact and expressed in Newtons.

13.1.6 *Height of rebound:* The measured distance (in mm) between the base plane and the maximum displacement of the impactor above the base plane.

13.1.7 *Impactor:* The striking part of the test apparatus.

13.1.8 *Impact velocity:* The velocity of the impactor, expressed in m/s, immediately prior to crossing the base plane on impact.

13.1.9 *Theoretical drop height:* A calculated drop height which equates the measured velocity of the impactor at the moment of impact to a height that would generate the same velocity if the test were performed at sea level and there was no friction to retard the impactor during a drop from that height.

13.1.10 *Slider:* A test body of given mass and geometry for measuring frictional characteristics of the horse body. The slider includes a test sole which is bonded to the bottom of the slider and is made of synthetic material with defined friction properties.

13.1.11 *Maximum traction force:* Maximum force, expressed in Newtons, applied during the pulling movement of the slider.

13.1.12 *Friction coefficient of horse body:* Quotient of the maximum traction force (in N) and the weight of the slider (in N).

13.1.13 *Displacement of pommels:* Relative and horizontal displacement (in mm) between a pair of pommels at a defined horizontal stretching force.

13.1.14 *Residual displacement of pommels:* Residual displacement (in mm) between the pommels after the removal of the stretching force.

13.1.15 *Testing belt:* A belt for measuring frictional properties of the pommels. The surface of the belt is made of synthetic material of defined frictional properties.

13.1.16 *Friction force of pommel:* The friction force, expressed in Newtons, generated by the contact of the testing belt and the specimen pommel.

13.1.17 *Friction coefficient of pommel:* Quotient of the friction force (in N) and the pulling-down weight of the testing belt (in N).

14 Principle of Measurement

14.1 *The complete test procedures include 4 parts:* Determination of shock absorption of horse body, determination of top friction of horse body, determination of positional stability of pommels, and determination of friction of pommels.

14.1.1 *Test A - Shock absorption of horse body:* A specimen horse body is impacted with an impactor of given mass and geometry at a specified velocity. A transducer mounted in the impactor monitors the acceleration – time history of the impactor which is recorded with the aid of a data acquisition system. An additional transducer may be used to monitor the displacement – time history of the impactor.

14.1.2 *Test B - Top friction of horse body:* A slider is pulled horizontally upon the surface of a specimen horse body at a defined loading rate. A transducer connected to the pulling cable monitors the maximum traction force generated during the pulling movement.

14.1.2.1 *Test C - Positional stability of pommels:* A pair of specimen pommels is stretched outward in the horizontal direction at a defined stretching force. The incremental displacement between the pommels during the time of force application is monitored. Residual displacement between the pommels is also monitored after the removal of the stretching force.

14.1.3 *Test D - Friction of pommels:* A testing belt is hung on a specimen pommel and pulled down at a defined weight. The frictional resistance force of the pommel is monitored.

14.2 Data obtained during these procedures are indicative of the cushioning properties and the top friction characteristics of the horse body and the positional stability and frictional properties of the pommels used in training and FIG-sanctioned competitions.

15 Performance Requirements

15.1 *Test A – Shock absorption of the horse body:* When tested according to the procedures described in Section 9.1, the values of the measured variables shall meet the performance requirements specified in Table 1.

15.2 *Test B – Top friction of the horse body:* When tested according to the procedures described in Section 9.2, the mean values of the measured variables shall meet the performance requirements specified in Table 2.

15.3 *Test C – Positional stability of the pommels:* When tested according to the procedures described in Section 9.3, the mean values of the measured variables shall be within the figures of Table 3.

Table 1: Figures for Test A – Shock absorption of the horse body

See Figure 1 for an illustration of the impact sites.
x represents the mean values of the measured variables

	Deflection (mm)	***Height of rebound*** (mm)	F_{max} (N)
Mean values across impact sites 1 to 5	$16 \leq x \leq 42$	$80 \leq x \leq 205$	$x \leq 12000$
Difference between highest and lowest mean values on impact sites 1 to 5	≤ 16	≤ 130	≤ 2500

Table 2: Figures for Test B – Top friction of the horse body

x represents the mean value of the measured variable

	Friction coefficient of horse body
Mean value across test sites 1 to 3	$0.35 \leq x \leq 0.60$
Difference between highest and lowest mean value on test sites 1 to 3	≤ 0.05
Difference between mean values of orthogonal test directions	≤ 0.05

Table 3: Figures for Test C – Positional stability of the pommels

x represents the mean values of the measured variables

Displacement of pommels (mm)	$x \leq 15.0$
Residual displacement of pommels (mm)	$x \leq 1.0$

Table 4: Figures for Test D – Friction of the pommels

x represents the mean value of the measured variable

	Friction coefficient of pommel

Mean value of both pommels	$0.45 \leq x \leq 0.80$
Difference between two pommels	≤ 0.05

15.4 *Test D – Friction of the pommels:* When tested according to the procedures described in Section 9.4, the mean values of the measured variable shall be within the figures of Table 4.

16 Test Apparatus

16.1 *Test A – Shock absorption of horse body:*

16.1.1 *Impact test machine:* Any type of dynamic testing apparatus that is capable of impacting a test specimen at a prescribed impact velocity and monitoring and recording the acceleration - time history of the impactor is acceptable. The impact test machine and the impactor shall have sufficient rigidity to eliminate undesirable vibrations in the apparatus which might be recorded on the acceleration - time curve. The impact test machine shall also be designed in such a manner that only the impact face contacts the test specimen at any time during the test procedures.

16.1.2 *Impactor:* The impactor shall be 10 kg ± 0.1 kg and shall have a flat impact face with a 10 cm ± 0.5 cm diameter. The edge of the impactor face should be relieved to eliminate sharp edges. Provision shall be made so that the accelerometer can be securely fastened parallel to the vertical axis of the impactor with a maximum deviation of ± 5º.

16.1.3 *Recording equipment - The recording equipment shall meet the following criteria:*

16.1.3.1 *Acceleration - time:* The selection of the specific acceleration - time recording equipment, including transducers and recorders, is at the discretion of the test laboratory. However, the recording system shall have a frequency response adequate to measure the peak acceleration value to an accuracy of ± 5% of the true value. The total system, detection and recording, shall be capable of measuring impact accelerations of up to 200 g at frequencies from 2 to 1000 Hz to an accuracy of ± 5%. The minimum sampling rate of the data acquisition system shall be 5000 Hz.

16.1.3.2 *Displacement - time:* It is optional, but desirable, that the displacement - time history is recorded by a separate transducer. Any transducer that provides a linear signal proportional to the displacement of the impactor along the impact axis which can be monitored simultaneously with the acceleration - time trace is acceptable. If displacement is recorded, the test equipment shall have means to determine and record the top plane (base plane) of the test specimen from which the total deformation and rebound height are determined.

16.1.3.3 *Filtering:* The signal from all transducers shall be conditioned with a low pass filter which complies with Channel Class 1000 of SAE Recommended Practice J211. A fourth-order Butterworth low pass filter with a cut-off frequency of 1000 Hz meets this requirement.

16.2 *Test B - Top friction of the horse body:*

16.2.1 *Measurement device:* Any type of friction testing apparatus that is capable of pulling a slider on the surface of a specimen horse body at a given loading velocity is acceptable. During the test, the traction force – time history of the slider shall be monitored and recorded.

16.2.2 *Slider:* The slider shall have a mass of 5 kg ± 0.2 kg. A square-shaped test sole with a thickness of 10mm ± 0.5 mm and a size of 40 mm ± 1 mm shall be bonded to the bottom of the slider. The thickness of the test sole shall be decreased to 75% ± 5% of the original thickness at a pressure of 5 N/cm^2. The coefficient of static friction of the test sole shall be 0.25 ± 0.03.

16.2.3 The slider shall be pulled at a constant loading rate of 5 N/s ± 0.5 N/s.

16.2.4 *Recording equipment - The recording equipment shall meet the following criteria:*

16.2.4.1 *Force - time:* The selection of the specific force - time recording equipment, including transducer and recorder, is at the discretion of the test laboratory. The total system, detection and recording, shall be capable of measuring traction forces up to 100 N at frequencies from 2 to 100 Hz to an accuracy of ± 3%. The minimum sampling rate of the data acquisition system shall be 200 Hz.

16.3 *Test C - Positional stability of the pommels:*

16.3.1 *Measurement device:* Any type of static testing apparatus that is capable of stretching a pair of pommels outward in the horizontal direction with a given force, and monitors and records the static displacement between the pommels is acceptable.

16.3.2 *Static stretching force:* The static stretching force shall be 600 N ± 20 N, horizontally applied between the pommels.

16.3.3 *Recording equipment for the static displacement:* The selection of the specific measurement equipment is at the discretion of the test laboratory. However, the accuracy of the measurement shall be ± 0.1 mm.

16.4 *Test D - Friction of the pommels:*

16.4.1 *Measurement device:* Any type of friction testing apparatus that is capable of measuring the static friction force of a pommel is acceptable. A pommel shall be set like a pulley with a testing belt hung on it. One end of the testing belt shall be pulled by the weight of 5 kg ± 0.2 kg The traction force of the other end shall be measured. See Figure 4 for an illustration.

16.4.2 *Testing belt:* The width of the testing belt shall be 20 mm ± 1 mm. The contacting side of the testing belt shall have a layer with a thickness of 10 mm ± 0.5 mm. The thickness of the layer shall be decreased to 75% ± 5% of the original thickness at a pressure of 5 N/cm^2. The coefficient of static friction of the layer shall be 0.25 ± 0.03.

16.4.3 *Recording equipment for the static displace-*

ment: The selection of the specific measurement equipment is at the discretion of the test laboratory. However, the system shall be capable of measuring traction force up to 100 N to an accuracy of ± 3%.

17 Test Specimen

17.1 The test specimen submitted for testing shall consist of a complete pommel horse as it is intended to be used during training and/or competition.

17.2 The test specimen shall comply with FIG Apparatus Rules: II-MAG2.

18 Conditioning and Test Temperature

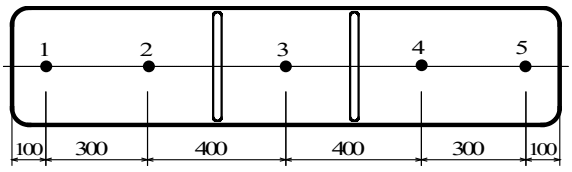
18.1 The test specimen shall be preconditioned at 50% ± 10% relative humidity and 21° C ± 3° C for a minimum of 24 hours prior to the test. All testing shall be carried out under the same conditions.

19 Laboratory Procedure (Test Method)

19.1 *Test A – Shock absorption of the horse body:*

19.1.1 *Impact sites:* A total of five impact sites shall be designated on the test specimen. See Figure 1 for an illustration of the impact sites.

Figure 1: Impact sites on the horse body (distances in mm)



19.1.2 *Impact test procedures:*

19.1.2.1 Place the test specimen under the impact test machine on a smooth, solid and horizontal floor (concrete or metal plate) and orient the impactor such that the centre of the impact face will contact one of the designated impact test sites.

19.1.2.2 Raise the impactor to an appropriate drop height such that it will contact the test specimen with an impact velocity of 2.80 m/s ± 3%. This corresponds to a theoretical drop height of 0.4 m.

19.1.2.3 Release the impactor and capture the acceleration - time history and displacement - time history (if applicable) using recording equipment described in Section 6.1.3.

19.1.2.4 Upon completion of a given impact test, raise the impactor off the surface of the test specimen.

19.1.2.5 The duration between tests at a given impact site shall not be less than 120 seconds.

19.1.2.6 Each test specimen shall receive a total of 50 impacts. Impact each of the five impact sites ten times.

19.1.3 *Calculations:*

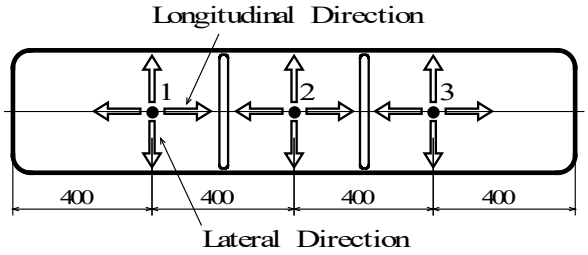
19.1.3.1 Immediately following each test, record the following measurements: Deflection (mm), Height of rebound (mm) and F_{max} (N).

19.1.3.2 The last eight tests for each impact site shall be used to determine the arithmetic mean value of a measured variable for each impact site and for the overall mean value of a measured variable across all impact sites.

19.2 Test B – Top friction of the horse body:

19.2.1 *Test sites and directions:* A total of three test sites shall be designated on the test specimen as illustrated in Figure 2. Four orthogonal test directions for the traction of the slider shall be also designated on each test site as illustrated in Figure 2.

Figure 2: Top friction test sites and directions on the horse body (distances in mm)



19.2.2 *Friction test procedures:*

19.2.2.1 Place the complete test specimen on a smooth, solid and horizontal floor.

19.2.2.2 Put the slider on the pommel horse in such a manner that the centre of its sole will contact one of the designated test sites, and also in such a manner that the pulling direction of the slider will conform to one of the designated test directions. Immediately prior to placing the slider, magnesium carbonate powder of 1g shall be spread on the surface of the test site. This shall be repeated prior to each test.

19.2.2.3 Pull the slider horizontally at a constant loading rate of 5 N/s ± 0.5 N/s and capture the traction force – time history using the recording equipment described in Section 6.2.4.

19.2.2.4 Repeat the procedure given in 9.2.2.2 and 9.2.2.3 five times at each test site and in each test direction.

19.2.2.5 Each test specimen shall receive a total of 60 friction test procedures.

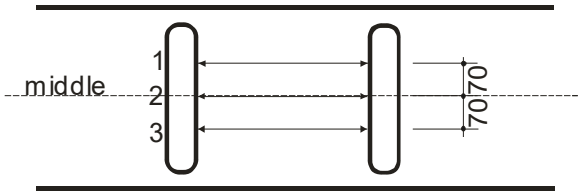
19.2.3 *Calculations:*

19.2.3.1 Immediately following each test, calculate and record the friction coefficient.

19.2.3.2 Determine the overall mean value of the friction coefficients across the test sites 1 to 3. Determine also the difference between the highest and the lowest mean value of the friction coefficient between all test sites, and the difference between mean values of the friction coefficients of orthogonal test directions between all test sites.

19.3 *Test C – Positional stability of the pommels:*
19.3.1 *Loading and measuring points:* A total of three pairs of loading points shall be designated on the test specimen as illustrated in Figure 3. The displacement shall be measured at these points.

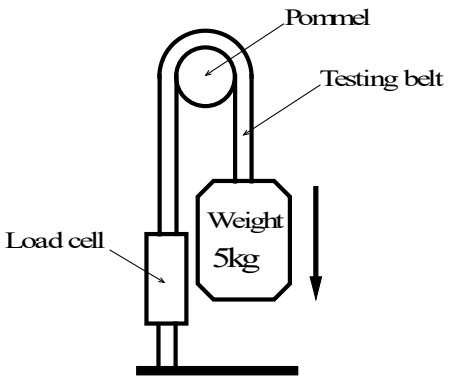
Figure 3: Loading and measuring points of the pommels (distances in mm)



1, 2, 3 Loading and measuring points

19.3.2 *Stretching test procedures:*
19.3.2.1 Place the complete test specimen on a smooth, solid and horizontal floor.
19.3.2.2 Set the loading device between the specimen pommels such that the loading axis will pass through one of the pairs of the loading points illustrated in Figure 3.
19.3.2.3 Stretch the specimen pommels horizontally up to the stretching force of 600 N ± 20 N and measure the incremental displacement between the specimen pommels using recording equipment described in Section 6.3.3. Measurement shall be done within 10 seconds after reaching the prescribed stretching force.
19.3.2.4 Measure the residual displacement between the specimen pommels 60 seconds after the removal of the stretching force.
19.3.2.5 Repeat the procedures given in 9.3.2.2, 9.3.2.3 and 9.3.2.4 at each of the specified loading points.
19.3.3 *Calculations:*
19.3.3.1 Immediately following each test, record the displacement of the pommels and the residual displacement of the pommels.
19.3.3.2 Determine the overall mean values of the measured variables for all loading points.
19.4 *Test D – Friction of the pommels:*
19.4.1 *Friction test procedures:*
19.4.1.1 Remove the specimen pommels from the horse body and fasten each pommel to the testing position such that the testing belt shall be hung on at the middle point of the specimen pommel.
19.4.1.2 Hang the testing belt on the pommel and connect one end of the testing belt to a transducer that can measure the traction force as illustrated in Figure 4. Immediately prior to hanging the testing belt, magnesium carbonate powder of 1 g shall be spread on the surface of the specimen pommel each time.
19.4.1.3 Pull the other end of the testing belt by the weight of 5 kg ± 0.2 kg and measure the traction force 10 seconds after weighting.

Figure 4: Setup of friction test of the pommels



19.4.1.4 Repeat the procedure given in 9.4.1.2 and 9.4.1.3 ten times for each pommel. Repeat the same procedure in the opposite frictional direction. A pair of specimen pommels shall receive a total of 40 friction test procedures.
19.4.2 *Calculations:*
19.4.2.1 Immediately following each test, record the traction force. The frictional force of the pommel is defined as the pulling weight minus the traction force. Use this value to calculate the friction coefficient of the pommel.
19.4.2.2 Determine the overall mean value of the friction coefficient for both pommels. Determine also the difference of the mean values of the friction coefficients between the two pommels.
19.5 Calculate the values of all required variables rounded to the decimal places of the corresponding figures identified in Section 5.

20 Report
20.1 *The test report shall include the following information:*
20.1.1 Complete identification of the tested pommel horse, including type, source, manufacturer's model number (if appropriate), dimensions of test specimen, and any other pertinent information. Photographs may be included in the test report for sample documentation purposes.
20.1.2 Test identification number according to the internal regulations between the FIG Test Institutes.
20.1.3 Complete identification of the testing laboratory including test technician and test laboratory manager (if appropriate).
20.1.4 Conditions under which the tests were made, including test date, temperature and humidity.
20.1.5 Identification of performed parts of the test – Test A, Test B, Test C and Test D.
20.1.6 Description of the impactor mass and the drop height conditions (Test A), mass, loading rate of the slider (Test B), static load (Test C) and the weight of the testing belt (Test D).

20.1.7 Description of all test results related to the performance requirements identified in Section 5.

20.1.8 Supplemental description of the test results:

20.1.8.1 Maximum value, minimum value and standard deviation of deflection, height of rebound and F_{max} variables according to Test A.

20.1.8.2 Mean values of deflection, height of rebound and F_{max} for the last eight tests at each impact site according to Test A.

20.1.8.3 Deflection, height of rebound and F_{max} values for all tests according to Test A.

20.1.8.4 Mean values and standard deviations of the friction coefficient at each test site and direction according to Test B.

20.1.8.5 Friction coefficient values for all tests according to Test B.

20.1.8.6 Displacement of the pommels and residual displacement of the pommels for all loading points according to Test C.

20.1.8.7 Mean values and standard deviations of friction coefficient of each pommel and frictional direction according to Test D.

20.1.8.8 Friction coefficient values for all tests according to Test D.

Standard Specification: Rings for Men Artistic Gymnastics

This standard is issued under the fixed designation FIG: IV-MAG3-01.04.2026; the numbers immediately following the designation indicate the date of original adoption by the FIG, or, in case of revision, the date of the last revision. This FIG standard was prepared by the Apparatus Commission of the FIG and participating FIG test laboratories. This standard was originally published in English only.

Introduction

The objective of this FIG standard is to provide equal opportunities for all athletes in FIG competitions by controlling the functional properties of rings and to minimize any differences between competition and training equipment.

1 Scope

1.1 This specification covers the inspection of stability for rings. This standard specification is applicable to all ring frames that are to be used at any FIG-sanctioned event.

1.2 This specification does not imply that an injury cannot be incurred while using a ring frame which complies with this specification.

1.3 The test procedures associated with this standard may involve hazardous operations and equipment. This standard does not purport to address all the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to use.

2 Normative References

2.1 International Gymnastics Federation (FIG): Apparatus Rules: II-MAG3

3 Terminology

3.1 *Description of terms specific to this standard:*

3.1.1 *Static tractive force*: The predetermined value of force exerted on one ring while pulling the ring vertically downwards.

3.1.2 *Starting position:* The vertical position of the unloaded ring within the mounted ring frame before loading it with a defined static tractive force. The lower inner side of the ring shall serve as the point of reference.

4 Principle of Measurement

4.1 The rings of a mounted ring frame are pulled vertically downwards with a predetermined static tractive force. After the release of the static tractive force the rings must return into the starting position.

5 Performance Requirements

When tested according to the procedures described in Section 9, the rings shall return into the starting position within a tolerance of 5mm and no damage or residual deflection shall be observable.

6 Test Set-up and Apparatus

6.1 Any type of test set-up is acceptable that is capable to stress the test specimen under prescribed conditions.

6.2 The device which applies the test load to the ring shall have a width of 35mm ± 1mm.

7 Test Specimen

7.1 The test specimen submitted for testing shall consist of a complete ring frame as it is intended to be used during training and/or competition.

7.2 The test specimen shall comply with FIG Apparatus Rules: II-MAG3.

8 Conditioning and Test Temperature

8.1 The ring frame, mounted and assembled for use, shall be preconditioned at 50% ± 10% relative humidity and 21° C ± 3° C for a minimum of 24 hours prior to the test. All testing shall be carried out under the same conditions.

9 Laboratory Procedure (Test Method)

9.1 Mount the ring frame with the rings at a height as prescribed for competitions (see Part II).

9.2 Install the traction device on one ring and pull the ring downwards with a static tractive force of 1500N. Release the force and determine the starting position after 2 min ± 15 sec.

9.3 Pull the ring vertically downwards with a static tractive force of 4000 N ± 40 N.

9.4 After the release of the static tractive force verify whether the ring returns into the starting position ± 5mm. The measurement shall be taken 30 sec ± 10 sec after the release of the force. Report any fraction or observed permanent deflection in any part of the test specimen.

9.5 Repeat the procedure given in 9.2 to 9.5 for the other ring.

10 Report

10.1 *The test report shall include the following information:*

10.1.1 Complete identification of the tested ring frame, including type, source, manufacturer's model number (if appropriate), dimensions of test specimen, and any other pertinent information. Photographs may be included in the test report for sample documentation purposes.

10.1.2 Test identification number according to the internal regulations between the FIG Test Institutes.

10.1.3 Complete identification of the testing laboratory including test technician and test laboratory man-

ager (if appropriate).

10.1.4 Conditions of test, including test date, temperature and humidity.

10.1.5 Test height of the rings and cable tension of the mounted and unloaded ring frame.

10.1.6 Description of the static tractive force.

10.1.7 Description whether fracture or other damage has occurred or if any permanent deformation has been observed after the test.

This standard is subject to revision at any time by the FIG Apparatus Commission. You are invited to comment on revision of this standard or on additional standards. Comments should be addressed to the FIG General Secretary.

Standard Specification: Vaulting Tables for Men Artistic Gymnastics

This standard is issued under the fixed designation FIG: IV-MAG4new-01.02.2001; the numbers immediately following the designation indicate the date of original adoption by the FIG, or, in case of revision, the date of the last revision. This FIG standard was prepared by the Apparatus Commission of the FIG and participating FIG test laboratories. This standard was originally published in English only.

Introduction

The objective of this FIG standard is to provide equal opportunities for all athletes in FIG competitions by controlling the functional properties of vaulting tables and to minimize any differences between competition and training equipment.

1 Scope

1.1 This specification covers the measurement of the profile dimensions, certain shock-absorbing characteristics, the impact force - time relationships, and the rebound properties of vaulting tables. This standard specification is applicable to all vaulting tables that are to be used at any FIG-sanctioned event.

1.2 This specification does not imply that an injury cannot be incurred while using a vaulting table which complies with this specification.

1.3 The test procedures associated with this standard may involve hazardous operations and equipment. This standard does not purport to address all the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to use.

2 Normative References

2.1 Society of Automotive Engineers: SAE J211 Recommended Practice for Instrumentation for Impact Tests – Requirements for Channel Class 1000, October 1988.

2.2 International Gymnastics Federation (FIG): Apparatus Rules: II-MAG4new.

3 Terminology

3.1 *Description of terms specific to this standard:*

3.1.1 *Acceleration:* The instantaneous time rate of change of velocity, expressed in m/s^2, which may be positive or negative.

3.1.2 *Starting position of an impact site:* The vertical position of an impact site at the surface of an unloaded vaulting table from which the total deflection and total height of rebound is determined.

3.1.3 *Deflection:* The measured distance (in mm) between the starting position of an impact site and the maximum displacement of the impactor below the starting position of an impact site.

3.1.4 *Force (F):* The product of the mass of the impactor, expressed in kg, and the acceleration of the impactor, expressed in m/s^2.

3.1.5 *Maximum Force (F_{max}):* The maximum value of force measured during the impact and expressed in Newtons.

3.1.6 *Height of rebound:* The measured distance (in mm) between the starting position of an impact site and the maximum displacement of the impactor above the starting position of an impact site.

3.1.7 *Impactor:* The striking part of the test apparatus.

3.1.8 *Impact velocity:* The velocity of the impactor, expressed in m/s, immediately prior to crossing the starting position of an impact site on impact.

3.1.9 *Theoretical drop height:* A calculated drop height which equates the measured velocity of the impactor at the moment of impact to a height that would generate the same velocity if the test were performed at sea level and there was no friction to retard the impactor during a drop from that height.

4 Principle of Measurement

4.1 A test specimen is impacted at a specified velocity with an impactor of given mass and geometry. A transducer mounted in the impactor monitors the acceleration – time history of the impactor which is recorded with the aid of a data acquisition system. An additional transducer may be used to monitor the displacement – time history of the impactor.

4.2 Dynamic data obtained during these procedures are indicative of the cushioning and rebound properties of vaulting tables used in training and FIG-sanctioned competitions.

5 Performance Requirements

5.1 When tested according to the procedures described in Section 9, the overall mean values and maximum ranges of the measured variables across all impact sites shall be within the figures of Table 1.

Table 1: Figures for Vaulting Tables

x represents the mean value of the measured variable

	Deflection (mm)	***Height of rebound (mm)***	***F_{max} (N)***
Mean value	$34 \le x \le 44$	$120 \le x \le 180$	$x \le 2500$
Max. range	≤ 10	≤ 75	≤ 550

6 Test Apparatus

6.1 *Profile dimension test device:* The selection of the specific profile dimension test device, including transducers and recorders, is at the discretion of the test laboratory. However, the recording system shall be capa-

ble of measuring profile dimensions at specific measurement points orthogonal to the given standard profile line to an accuracy of ± 0.5 mm. The total system, detection and recording, shall be capable of measuring proportional profile dimensions at specific measurement lines (see Section 9.1).

6.2 *Impact test machine:* Any type of dynamic testing apparatus that is capable of impacting a test specimen at a prescribed impact velocity monitoring and recording the acceleration - time history of the impactor is acceptable. The impact test machine and the impactor shall have sufficient rigidity to eliminate undesirable vibrations in the apparatus which might be recorded on the acceleration - time curve. The impact test machine shall also be designed in such a manner that only the impact face contacts the test specimen at any time during the test procedures.

6.3 *Impactor:* The impactor shall be 10 kg ± 0.1 kg and shall have a flat impact face with a 10 cm ± 0.5 cm diameter. The edge of the impactor face should be relieved to eliminate sharp edges. Provision shall be made so that the accelerometer can be securely fastened parallel to the vertical axis of the impactor with a maximum deviation of ± 5º.

6.4 *Recording equipment - The recording equipment shall meet the following criteria:*

6.4.1 *Acceleration - time:* The selection of the specific acceleration - time recording equipment, including transducers and recorders, is at the discretion of the test laboratory. However, the recording system shall have a frequency response adequate to measure the peak acceleration value to an accuracy of ± 5% of the true value. The total system, detection and recording, shall be capable of measuring impact accelerations of up to 200 g at frequencies from 2 to 1000 Hz to an accuracy of ± 5%. The minimum sampling rate of the data acquisition system shall be 5000 Hz.

6.4.2 *Displacement - time:* It is optional, but desirable, that the displacement - time history is recorded by a separate transducer. Any transducer that provides a linear signal proportional to the displacement of the impactor along the impact axis which can be monitored simultaneously with the acceleration - time trace is acceptable. If displacement is recorded, the test equipment shall have means to determine and record the starting position of an impact site from which the total deformation and rebound height are determined.

6.4.3 *Filtering:* The signal from all transducers shall be conditioned with a low pass filter which complies with Channel Class 1000 of SAE Recommended Practice J211. A fourth-order Butterworth low pass filter with a cut-off frequency of 1000 Hz meets this requirement.

7 Test Specimen

7.1 The test specimen submitted for testing shall consist of a complete vaulting table as it is intended to be used during training and/or competition.

7.2 The test specimen shall comply with FIG Apparatus Rules: II-MAG4new.

7.3 The profile dimensions of the test specimen shall be inspected according to the procedures described in Section 9.1.

8 Conditioning and Test Temperature

8.1 Test specimens shall be preconditioned at 50% ± 10% relative humidity and 21º C ± 3º C for a minimum of 24 hours prior to the test. All testing shall be carried out under the same conditions.

9 Laboratory Procedure (Test Method)

9.1 *Profile dimension measurement:*

9.1.1 *Measurement locations:* A total of 42 measurement points (MP) on five measurement lines are used to inspect the profile dimensions. In longitudinal direction there are 14 measurement points on the center measurement line of the test specimen (MP1 and MP16 are not required for standardization). In transversal direction there are 28 measurement points, seven at each measurement line (four transversal lines, orthogonal crossing the center measurement line at MP4, MP5, MP7 and MP9). See Figures 1-3 for illustrations of the measurement points.

9.1.2 *Profile dimension measurement procedures:*

9.1.2.1 Place the test specimen under the profile dimension test device on a horizontal, smooth and solid floor.

9.1.2.2 Determine the proportional profile dimensions for each measurement line (four transversal profiles and one longitudinal profile).

9.1.3 *Determination of the orthogonal deviations to the standard profile (in orientation of the designated arrows in Figures 1 and 3):*

9.1.3.1 *Longitudinal direction:* Compare the actual profile to the standard profile by crossing (overlaying) the profiles in MP5 and MP14 (i.e. the deviation in these measurement points is set to zero by shifting the profiles in horizontal and vertical direction without rotation). Calculate the deviations at the remaining measurement points.

9.1.3.2 *Transversal direction:* Compare the actual profile to the standard profile for each transversal measurement line by crossing (overlaying) the profiles in the center measurement point N4 (i.e. the deviation in this measurement points is set to zero by shifting the profiles in horizontal and vertical direction without rotation). Calculate the deviations at the remaining measurement points.

Figure 1: Dimension Measurement Locations for Vaulting Tables – Measurement Points on Center Line in Longitudinal Direction (MP1 – MP16)
(Side view - distances in cm)

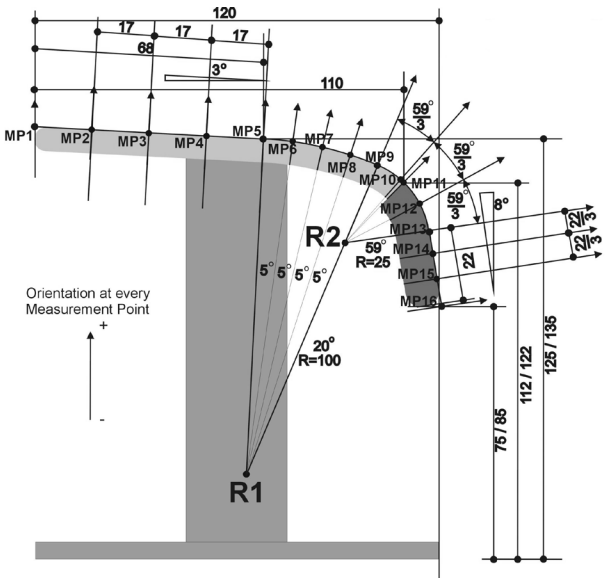


Figure 2: Dimension Measurement Locations for Vaulting Tables – Measurement Lines in Transversal Direction (Line MP4 / MP5 / MP7 / MP9)
(Frontal view - distances in cm)

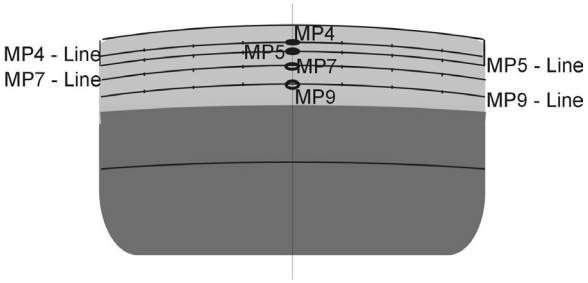
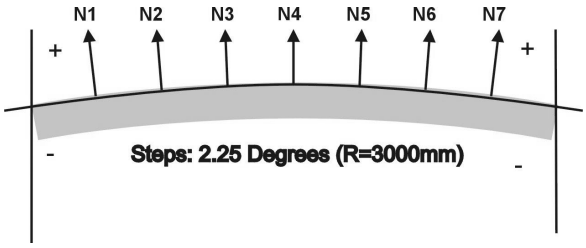
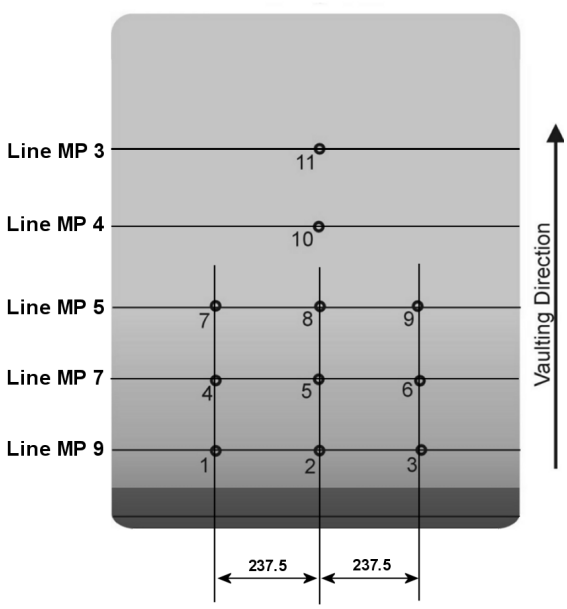


Figure 3: Dimension Measurement Locations for Vaulting Tables – Measurement Points on Measurement Lines in Transversal Direction (N1 – N7)
(Transverse section)



9.2 *Impact locations:* A total of eleven impact sites shall be designated on the test specimen. See Figure 4 for an illustration of the impact sites.

Figure 4: Impact Locations for Vaulting Tables
(Oversight view - distances in mm)



9.3 *Impact test procedures:*

9.3.1 Place and tilt the test specimen under the impact test machine such that the centre of the impact face of the impactor will contact one of the designated impact test sites perpendicular to the surface of the vaulting table. See Figures 5-7 for illustrations of the tilted test positions. It is optional, but desirable, to enable the necessary tilt angles of the test specimen by attaching the test specimen to a smooth, solid metal plate with the same inclination.

Figure 5: Impact Test Setup for Test Points 1,2,3

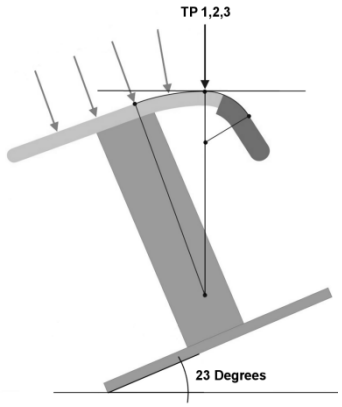


Figure 6: Impact Test Setup for Test Points 4,5,6

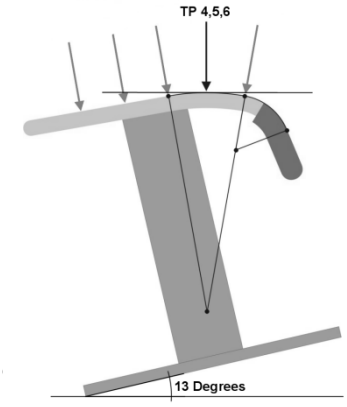
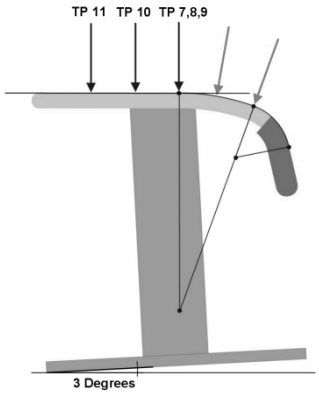


Figure 7: Impact Test Setup for Test Points 7 – 11



9.3.2 Raise the impactor to an appropriate drop height such that it will contact the test specimen with an impact velocity of 2.80 m/s ± 3 %. This corresponds to a theoretical drop height of 0.4 m.

9.3.3 Release the impactor and capture the acceleration - time history and displacement - time history (if applicable) using recording equipment described in Section 6.4.

9.3.4 Upon completion of a given impact test, raise the impactor off the surface of the test specimen.

9.3.5 The duration between tests at a given impact site shall not be less than 120 seconds.

9.3.6 Each test specimen shall receive a total of 110 impacts. Impact each of the eleven impact sites ten times.

9.4 *Calculations:*

9.4.1 Immediately following each test, record the following measurements: F_{max} (N), Deflection (mm) and Height of rebound (mm).

9.4.2 The last eight tests for each impact site shall be used to determine the arithmetic mean value of a measured variable for each impact site and for the overall mean value of a measured variable across all impact sites.

9.4.3 Calculate the mean values of Deflection, Height of rebound and F_{max} across all impact sites rounded to zero decimal places.

10 Report

10.1 *The test report shall include the following information:*

10.1.1 Complete identification of the tested vaulting table, including type, source, manufacturer's apparatus denomination, manufacturer's model number (if appropriate), dimensions of test specimen, and any other pertinent information. Photographs may be included in the test report for sample documentation purposes.

10.1.2 Description of the profile dimensions relative to the requirements in FIG Apparatus Rules: II-MAG4new.

10.1.3 Test identification number according to the internal regulations between the FIG Test Institutes.

10.1.4 Complete identification of the testing laboratory including test technician and test laboratory manager (if appropriate).

10.1.5 Conditions of test, including test date, temperature and humidity.

10.1.6 Description of the impactor mass and the drop height conditions.

10.1.7 Description of the test results relative to the performance requirements identified in Section 5.

10.1.8 Mean values of Deflection, Height of rebound and F_{max} across all impact sites.

10.1.9 Maximum value, minimum value and standard deviation of Deflection, Height of rebound and F_{max} variables.

10.1.10 Mean values of Deflection, Height of rebound and F_{max} for the last eight tests at each impact

site.

10.1.11 Deflection, Height of rebound and F_{max} values for all tests.

This standard is subject to revision at any time by the FIG Apparatus Commission. You are invited to comment on revision of this standard or on additional standards. Comments should be addressed to the FIG General Secretary.

Standard Specification: Parallel Bars for Men Artistic Gymnastics

This standard is issued under the fixed designation FIG: IV-MAG5-11.05.2010; the numbers immediately following the designation indicate the date of original adoption by the FIG, or, in case of revision, the date of the last revision. This FIG standard was prepared by the Apparatus Commission of the FIG and participating FIG test laboratories. This standard was originally published in English only.

Introduction

The objective of this FIG standard is to provide equal opportunities for all athletes in FIG competitions by controlling the functional properties of parallel bars and to minimize any differences between competition and training equipment.

1 Scope

1.1 This specification covers the measurement of certain static stiffness properties, dynamic force - time and displacement - time relationships as well as oscillation and stability characteristics of parallel bars. This standard specification is applicable to all parallel bars that are to be used at any FIG-sanctioned event.

1.2 This specification does not imply that an injury cannot be incurred while using parallel bars which comply with this specification.

1.3 The test procedures associated with this standard may involve hazardous operations and equipment. This standard does not purport to address all the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to use.

2 Normative References

2.1 International Gymnastics Federation (FIG): Apparatus Rules: II-MAG5.

2.2 International Gymnastics Federation (FIG): Apparatus Rules: IV-MAG6.

3 Terminology

3.1 *Description of terms specific to this standard:*

3.1.1 *Bar linkage:* A rigid mechanical linkage between both bars of a parallel bars to exert equal forces simultaneously on both bars.

3.1.2 *Static tractive force*: The predetermined value of force (in N) exerted on the midpoint of the bar, pulling the bar vertically downwards.

3.1.3 *Starting position:* The position of an unloaded bar or an unloaded bar linkage from which the total deflection in vertical direction is determined. The midpoint of the bar or the bar linkage shall serve as the point of reference for the measurements.

3.1.4 *Deflection:* The measured distance (in mm) between the starting position and the maximum displacement of the midpoint of the bar or the bar linkage in vertical direction.

3.1.5 *Definition of spatial dimensions and test directions*: For the determination of the vertical deflection of the midpoint of the bar or the bar linkage the spatial dimensions are defined as illustrated in Figure 1 to 3. The test directions are defined as illustrated in Figure 4.

3.1.6 *Pendulum:* Tubular test body of given dimensions and mass with an additional low friction falling weight inside. The test body is attached to a bar or a bar linkage with the help of two inflexible grasping arms, each of which is at the same distance from the midpoint of the bar or the bar linkage, guaranteeing a low-friction rotation of the test body about the longitudinal axis of the bar or the bar linkage.

Figure 1: Definition of Spatial Dimensions
Test position: Middle of bars (lateral)
(Pendulum in horizontal position before release)

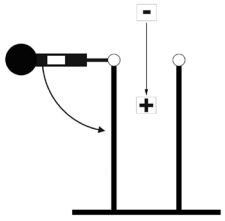


Figure 2: Definition of Spatial Dimensions
Test position: Middle of bars (transversal)
(Pendulum in horizontal position before release)

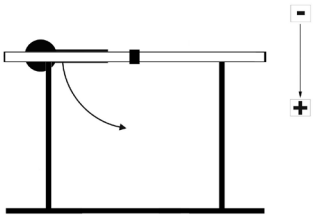


Figure 3: Definition of Spatial Dimensions
Test position: End of bars (transversal)
(Pendulum in horizontal position before release)

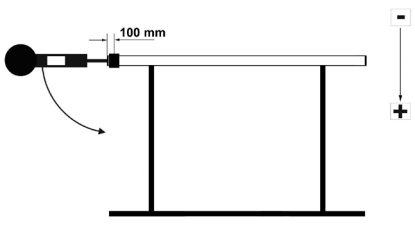
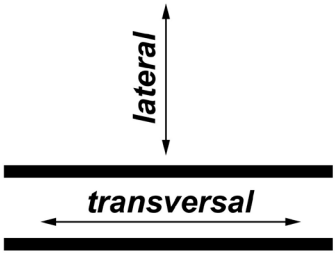


Figure 4: Definition of Test Directions



3.1.7 *Maximum Force (F_{max}):* The maximum value of the reaction force in the direction of the pendulum's centre of gravity measured as the sum of the forces exerted on both grasping arms during the pendulum swing, expressed in Newtons.

3.1.8 *Hanging position:* Stable equilibrium position of the hanging pendulum under gravity conditions only.

3.1.9 *Horizontal position:* Position of the attached pendulum rectangular to the hanging position.

3.1.10 *Additional falling weight:* Cylindrical test body of given dimensions and mass inside the pendulum producing an additional impact stress on the gymnastic apparatus during pendulum swing.

3.1.11 *Internal drop height:* Predetermined sliding distance of the additional falling weight inside the pendulum.

3.1.12 *Initial tension:* Predetermined value of the force (in N) exerted on the bar or the bar linkage, composed of the gravity of the attached pendulum and an additional tractive force pulling the bar-pendulum system vertically downwards.

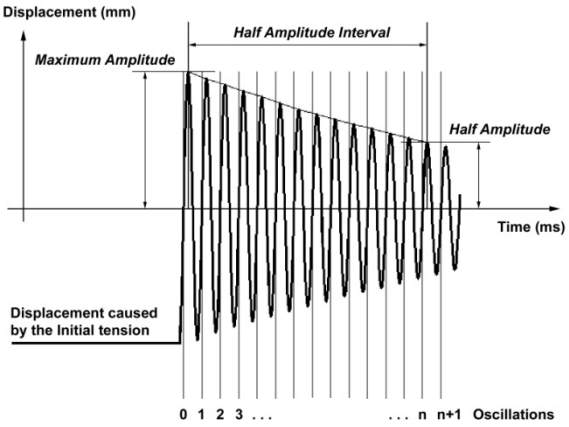
3.1.13 *Frequency of oscillation:* Reciprocal of the value determined by the duration of the half amplitude interval divided by the number of oscillations of the bar-pendulum system within the half amplitude interval. The frequency is expressed in Hertz. See Figure 5 for illustration of the frequency determination.

3.1.14 *Maximum amplitude:* Value of the amplitude (in mm) of the first oscillation of the bar-pendulum system after the release of the initial tension.

3.1.15 *Half amplitude:* Value of the amplitude (in mm) of the first oscillation which is equal to or less than half the maximum amplitude.

3.1.16 *Half amplitude interval:* Duration of oscillation (in ms) between the passage of the maximum amplitude and the reaching of the half amplitude. See Figure 5 for illustration.

Figure 5: Oscillation Damping Parameters



4 Principle of Measurement

4.1 *The complete measurement is composed of four specific test procedures:*

4.1.1 *Test A - Static traction stress:* A bar of a mounted apparatus is pulled vertically downwards with a predetermined static tractive force. A measuring device mounted on the bar monitors the displacement - time history of the midpoint of the bar caused by this force. The maximum deflection is recorded with the aid of a data acquisition system. After the release of the static tractive force the bar must return into the starting position.

4.1.2 *Test B - Stress by pendulum swing:* A pendulum which is attached to a bar or a bar linkage of a mounted apparatus is rotated from hanging position into horizontal position and then released. While it swings down, an additional falling weight inside the tubular pendulum slides down from a predetermined internal drop height until the weight strikes against the inside bottom of the pendulum, producing an additional impact stress on the gymnastic apparatus. A measuring device monitors the displacement - time history of the midpoint of the bar or the bar linkage. Load cells inside both pendulum grasping arms monitor the reaction force - time history of the pendulum. Both are recorded with the aid of a data acquisition system. The test measures the maximum reaction force in the direction of the pendulum's centre of gravity and the positive deflection of the bar or the bar linkage in vertical direction.

4.1.3 *Test C - Oscillation damping:* A pendulum which is attached to a bar or a bar linkage of a mounted apparatus is pulled vertically downwards until a predetermined initial tension is reached. The abrupt release causes a damped oscillation of the bar-pendulum system. A measuring device monitors the displacement - time history of the midpoint of the bar or the bar linkage which is recorded with the aid of a data acquisition system. The test measures the frequency as well as the half amplitude interval of the oscillation.

4.1.4 *Test D - Lateral stability:* One bar of a parallel bars which is ensured against sideward slipping is

pulled horizontally in lateral direction until a predetermined inclination of the parallel bars is reached. A load cell inside the towing cable monitors the tractive force - time history which is recorded with the aid of a data acquisition system. The test measures the tractive force in the predetermined inclination position of the parallel bars.

4.2 Static and dynamic data obtained during these procedures are indicative of the static stiffness, elastic, damping, oscillation and stability properties of parallel bars used in training and FIG-sanctioned competitions.

5 Performance Requirements

5.1 *Test A - Static traction stress:* When tested according to the procedures described in Section 9.2, the value of the measured variable shall be within the figures of Table 1.

Table 1: Figure for Test A – Static traction stress
x represents the measured variable

Test A: Static traction stress	
Deflection (mm)	$50 \le x \le 70$

5.2 *Test B - Stress by pendulum swing:* When tested according to the procedures described in Section 9.3, the mean values of the measured variables shall be within the figures of Table 2.

Table 2: Figures for Test B – Stress by pendulum swing
x represents the mean value of the measured variable

Test B: Stress by pendulum swing	
Middle of bars (lateral)	
F_{max} (N)	$x \le 2300$
Positive vertical deflection (mm)	$70 \le x \le 100$
Middle of bars (transversal)	
F_{max} (N)	$x \le 2750$
Positive vertical deflection (mm)	$47 \le x \le 62$
End of bars (transversal)	
F_{max} (N)	$x \le 3000$
Positive vertical deflection (mm)	$48 \le x \le 58$

5.3 *Test C - Oscillation damping:* When tested according to the procedures described in Section 9.4, the mean values of the measured variables shall be within the figures of Table 3.

Table 3: Figures for Test C – Oscillation damping
x represents the mean value of the measured variable

Test C: Oscillation damping	
Middle of bars (lateral)	
Frequency of oscillation (Hz)	$3.00 \le x \le 3.60$
Half amplitude interval (ms)	$400 \le x \le 2750$
Middle of bars (transversal)	
Frequency of oscillation (Hz)	$4.00 \le x \le 4.80$
Half amplitude interval (ms)	$400 \le x \le 2500$
End of bars (transversal)	
Frequency of oscillation (Hz)	$3.80 \le x \le 5.00$
Half amplitude interval (ms)	$400 \le x \le 1200$

5.4 *Test D - Lateral stability:* When tested according to the procedures described in Section 9.5., the value of the measured variable shall be within the figure of Table 4. If the parallel bars do not meet this requirement the manufacturer and the appropriate FIG authorities will be informed that at all FIG sanctioned competitions and events, the parallel bars must be fixed to the floor.

Table 4: Figure for Test D – Lateral Stability
x represents the measured variable

Test D: Lateral stability	
Tractive force (N)	$x \ge 900$

6 Test Set-up and Apparatus

6.1 *Set-up for Test A - Static traction stress*: Any type of test set-up is acceptable that is capable to stress the test specimen under prescribed conditions and monitoring and recording the displacement - time history of the midpoint of the bar.

6.2 *Set-up for Test B - Stress by pendulum swing:* Any type of test set-up is acceptable that is capable of stressing the test specimen with a pendulum swing under prescribed conditions and monitoring and recording the displacement - time history of the midpoint of the bar or the bar linkage and the reaction force - time history of the pendulum. It is optional, but desirable, that the pendulum is released from a magnet in the horizontal position.

6.3 *Set-up for Test C - Oscillation damping*: Any type of test set-up is acceptable that is capable of stressing a bar-pendulum system under prescribed conditions and monitoring and recording the displacement - time history of the midpoint of the bar or the bar linkage. It is optional, but desirable, that the bar-pendulum system is released from a magnet at the prescribed initial tension.

6.4 *Set-up for Test D - Lateral stability:* Any type of test set-up is acceptable that is capable to stress the test specimen under prescribed conditions and monitoring and recording the tractive force - time history of the towing cable.

6.5 *Bar linkage:* Any type of rigid mechanical linkage between the bars is acceptable which enables an attachment of the pendulum for all tests in transversal test direction. The bar linkage shall enable a distance between the bars of 52 cm ± 1 cm. The weight of the bar linkage shall be 3.0 kg ± 0.3 kg.

6.6 *Pendulum* - The pendulum shall meet the following criteria:

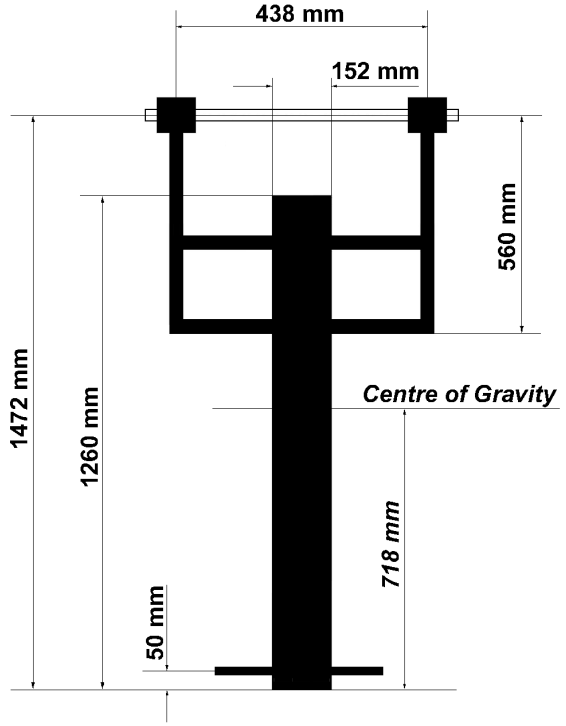
6.6.1 *Mass and geometry:* The tubular test body shall have a mass of 40.0 kg ± 3% (including load cells, grasping arms and appliances for additional weights) and a geometry as specified in Figure 6. The load cells shall be located between the test body and the grasping arms. The weight of each grasping arm shall be 1.0 kg ± 3%.

6.6.2 *Pendulum fixation* - The pendulum fixation to the bar shall meet the following criteria:

6.6.2.1 *Functional properties:* The fixation shall allow an immediate transfer of forces between pendulum and bar or bar linkage and guarantee a low-friction rotation of the pendulum about the longitudinal axis of a bar or a bar linkage (the use of roll bearings is recommended).

6.6.2.2 *Friction of the bar-pendulum fixation* - The frictional properties of the fixation shall meet the criteria as specified in *FIG Apparatus Rules: IV-MAG6 Standard Specification for Horizontal Bars for Men Artistic Gymnastics.*

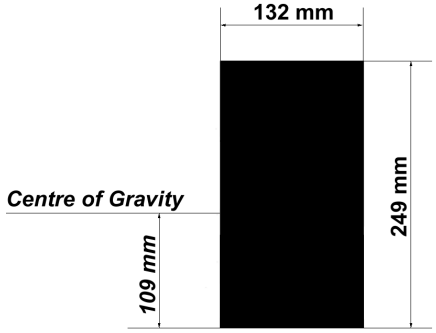
Figure 6: Geometry of Tubular Test Body
(All dimensions with an accuracy of 3%)



6.6.3 *Additional falling weight* - The additional falling weight shall meet the following criteria:

6.6.3.1 *Mass and geometry:* The cylindrical falling weight shall have a mass of 20.0 kg ± 0.2 kg and a geometry as specified in Figure 7.

Figure 7: Geometry of Additional Falling Load
(All dimensions with an accuracy of 3%)



6.6.3.2 *Friction within the tube of the test body* - The frictional properties of the additional falling weight shall meet the criteria as specified in *FIG Apparatus Rules: IV-MAG6 Standard Specification for Horizontal Bars for Men Artistic Gymnastics.*

6.6.3.3 *Damping of the additional falling weight at the inside bottom of the tubular test body:* The damping properties of the additional falling weight shall meet the criteria as specified in *FIG Apparatus Rules: IV-MAG6 Standard Specification for Horizontal Bars for Men Artistic Gymnastics.*

6.7 *Recording equipment* - The recording equipment shall meet the following criteria:

6.7.1 *Displacement - time:* The selection of the specific displacement - time recording equipment, including transducers and recorders, is at the discretion of the test laboratory. However, the transducers shall provide linear signals proportional to the displacement of the midpoint of the bar or the bar linkage. If displacement is recorded, the test equipment shall have means to determine and record the starting position of the bar or the bar linkage from which the total deflection is determined. The total system, detection and recording, shall be capable of measuring displacements of up to 200 mm at frequencies from 2 to 200 Hz to an accuracy of ± 1%. The minimum sampling rate of the data acquisition system shall be 500 Hz.

6.7.2 *Reaction force - time:* Any reaction force - time recording equipment, including load cells and recorders, which can monitor the reaction force exerted on the pendulum simultaneously with the displacement - time trace is acceptable. The total system, detection and recording, shall be capable of measuring reaction forces of up to 5000 N at frequencies from 2 to 200 Hz to an accuracy of ± 1%. The minimum sampling rate of the data acquisition system shall be 500 Hz.

6.7.3 *Tractive force:* Any tractive force recording

equipment, including load cells and recorders, which can monitor the tractive force exerted on the parallel bars is acceptable. The total system, detection and recording, shall be capable of measuring tractive forces of up to 5000 N to an accuracy of ± 1%.

7 Test Specimen

7.1 The test specimen submitted for testing shall consist of complete parallel bars as it is intended to be used during training and/or competition.

7.2 The test specimen shall comply with FIG Apparatus Rules: II-MAG5.

8 Conditioning and Test Temperature

8.1 The parallel bars, mounted and assembled for use, shall be preconditioned at 50% ± 10% relative humidity and 21° C ± 3° C for a minimum of 24 hours prior to the test. All testing shall be carried out under the same conditions.

9 Laboratory Procedure (Test Method)

9.1 *General set-up:*

9.1.1 Mount the parallel bars to a height as prescribed for competitions (Part II).

9.1.2 For Test A, B and C the parallel bars shall have a fixation to the floor to eliminate undesirable vibrations and movements of the apparatus.

9.2 *Test A - Static traction stress:*

9.2.1 Install the displacement measuring device on an unloaded bar and determine the starting position.

9.2.2 Pull the midpoint of one bar vertically downwards with a static tractive force of 1350 N ± 20 N and capture, then record the resulting maximum deflection (mm) using recording equipment described in Section 6.7.

9.2.3 After the release of the static tractive force verify whether the bar returns into the starting position.

9.3 *Test B - Stress by pendulum swing:*

9.3.1 Install the displacement measuring device on an unloaded bar (tests in lateral test direction) or the unloaded bar linkage (tests in transversal test direction) and determine the starting position.

9.3.2 Attach the pendulum (60 kg: 40 kg pendulum with additional 20 kg falling weight) to a bar or the bar linkage in hanging position.

9.3.3 Move the pendulum from hanging position into horizontal position and move the additional falling weight inside the pendulum to the 50 cm ± 1 cm internal drop height position. For the direction of the pendulum swing at the different test positions see Figure 1 to 3.

9.3.4 Release the pendulum and capture the displacement - time history of the midpoint of the bar or the bar linkage and the reaction force - time history of the pendulum, using recording equipment described in Section 6.7.

9.3.5 The parallel bars shall be stressed at each of the following test positions by repeating the pendulum swing five times: End of bars (transversal), Middle of bars (transversal), Middle of bars (lateral). See Figure 1 to 4 for illustration of the locations and the directions of the test positions.

9.3.6 Immediately following each test, record the following measurements: F_{max} (N) and positive vertical deflection (mm).

9.3.7 All five tests per test position shall be used to determine the arithmetic mean values of the measured variables.

9.4 *Test C - Oscillation damping:*

9.4.1 Attach the pendulum (60 kg: 40 kg pendulum with additional 20 kg falling weight at the inside bottom of the pendulum) to a bar (tests in lateral test direction) or the bar linkage (tests in transversal test direction) in hanging position.

9.4.2 Pull down the pendulum vertically until the initial tension of 1000 N ± 30 N is reached.

9.4.3 Release the pendulum and capture the displacement - time history of the midpoint of the bar or the bar linkage using recording equipment described in Section 6.7.

9.4.4 Repeat the above process for each test position (see 9.3.5) five times.

9.4.5 Immediately following each test, record the following measurements: Frequency (Hz) and half amplitude interval (ms) of the oscillation.

9.4.6 All five tests per test position shall be used to determine the arithmetic mean values of the measured variables.

9.5 *Test D - Lateral stability:*

9.5.1 Ensure the parallel bars against sideward slipping with a barrier at the base frame.

9.5.2 Mount the towing cables to one bar at the top of the uprights and pull horizontally in lateral direction until the test specimen tilts to an inclination of 10°. Capture, then record the tractive force (N) using recording equipment described in Section 6.7.

9.6 Calculate the values of all required variables rounded to the decimal places of the corresponding figures identified in Section 5.

10 Report

10.1 *The test report shall include the following information:*

10.1.1 Complete identification of the tested parallel bars, including type, source, manufacturer's model number (if appropriate), dimensions of test specimen, and any other pertinent information. Photographs may be included in the test report for sample documentation purposes.

10.1.2 Test identification number according to the internal regulations between the FIG Test Institutes.

10.1.3 Complete identification of the testing laboratory including test technician and test laboratory manager (if appropriate).

10.1.4 Conditions of test, including test date, temperature and humidity.

10.1.5 Test height of the parallel bars.

10.1.6 *Test A - Static traction stress:* Description of the static tractive force.

10.1.7 *Test B - Stress by pendulum swing:* Description of the pendulum mass, the additional falling weight and the internal drop height.

10.1.8 *Test C - Oscillation damping:* Description of the pendulum mass (including the additional falling weight at the inside bottom of the pendulum) and the initial tension.

10.1.9 *Test D - Lateral stability:* Description of the inclination of the parallel bars.

10.1.10 Description of the test results relative to the performance requirements identified in Section 5.

This standard is subject to revision at any time by the FIG Apparatus Commission. You are invited to comment on revision of this standard or on additional standards. Comments should be addressed to the FIG General Secretary.

Standard Specification: Horizontal Bars for Men Artistic Gymnastics

This standard is issued under the fixed designation FIG: IV-MAG6-29.03.1996; the numbers immediately following the designation indicate the date of original adoption by the FIG, or, in case of revision, the date of the last revision. This FIG standard was prepared by the Apparatus Commission of the FIG and participating FIG test laboratories. This standard was originally published in English only.

Introduction

The objective of this FIG standard is to provide equal opportunities for all athletes in FIG competitions by controlling the functional properties of horizontal bars and to minimize any differences between competition and training equipment.

1 Scope

1.1 This specification covers the measurement of certain static stiffness properties, dynamic force - time and displacement - time relationships and the oscillation characteristics of horizontal bars. This standard specification is applicable to all horizontal bars that are to be used at any FIG-sanctioned event.

1.2 The test procedures associated with this specification does not imply that an injury cannot be incurred while using a horizontal bar which complies with this specification.

1.3 This standard may involve hazardous operations and equipment. This standard does not purport to address all the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to use.

2 Normative References

2.1 International Gymnastics Federation (FIG): Apparatus Rules: II-MAG6.

3 Terminology

3.1 *Description of terms specific to this standard:*

3.1.1 *Cable tension*: The predetermined value of force (in N) exerted on the mounting cables of the completely mounted unloaded horizontal bar.

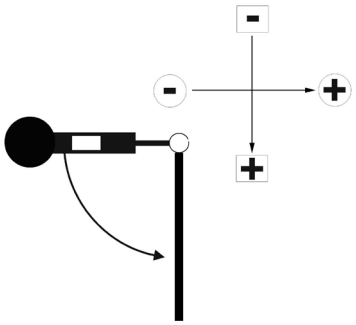
3.1.2 *Static tractive force*: The predetermined value of force (in N) exerted on the midpoint of the bar, pulling the bar vertically downwards.

3.1.3 *Starting position:* The position of the unloaded bar from which the total deflection in vertical and horizontal direction is determined. The midpoint of the bar shall serve as the point of reference for the measurements.

3.1.4 *Deflection:* The measured distance (in mm) between the starting position and the maximum displacement of the midpoint of the bar in vertical and horizontal direction respectively.

3.1.5 *Definition of spatial dimensions:* For the determination of the vertical and horizontal deflection of the midpoint of the bar the spatial dimensions are defined as illustrated in Figure 1.

Figure 1: Definition of Spatial Dimensions
(Pendulum in horizontal position before release)



3.1.6 *Pendulum:* Tubular test body of given dimensions and mass with an additional low-friction falling weight inside. The test body is attached to the bar with the help of two inflexible grasping arms, each of which is at the same distance from the midpoint of the bar, guaranteeing a low-friction rotation of the test body about the longitudinal axis of the bar.

3.1.7 *Maximum Force (F_{max}):* The maximum value of the reaction force in the direction of the pendulum's centre of gravity measured as the sum of the forces exerted on both grasping arms during the pendulum swing, expressed in Newtons.

3.1.8 *Hanging position:* Stable equilibrium position of the hanging pendulum under gravity conditions only.

3.1.9 *Horizontal position:* Position of the attached pendulum rectangular to the hanging position.

3.1.10 *Additional falling weight:* Cylindrical test body of given dimensions and mass inside the pendulum producing an additional impact stress on the gymnastic apparatus during pendulum swing.

3.1.11 *Internal drop height:* Predetermined sliding distance of the additional falling weight inside the pendulum.

3.1.12 *Initial tension:* Predetermined value of the force exerted on the bar, composed of the gravity of the attached pendulum and an additional tractive force pulling the bar-pendulum system vertically downwards.

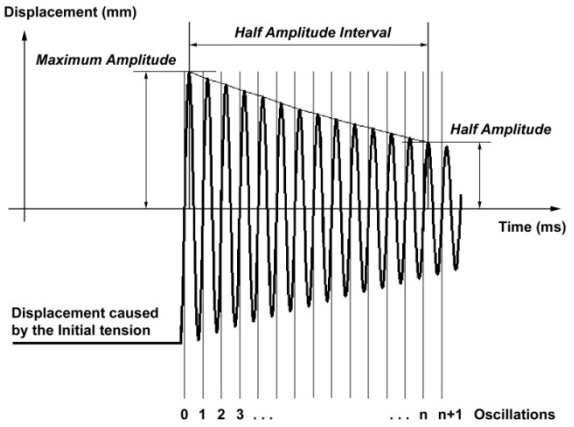
3.1.13 *Frequency of oscillation:* Reciprocal of the value determined by the duration of the half amplitude interval divided by the number of oscillations of the bar-pendulum system within the half amplitude interval. The frequency is expressed in Hertz. See Figure 2 for illustration of the frequency determination.

3.1.14 *Maximum amplitude:* Value of the amplitude (in mm) of the first oscillation of the bar-pendulum system after the release of the initial tension.

3.1.15 *Half amplitude:* Value of the amplitude (in mm) of the first oscillation which is equal to or less than half the maximum amplitude.

3.1.16 *Half amplitude interval:* Duration of oscillation (in ms) between the passage of the maximum amplitude and the reaching of the half amplitude. See Figure 2 for illustration.

Figure 2: Oscillation Damping Parameters



4 Principle of Measurement

4.1 *The complete measurement is composed of three specific test procedures:*

4.1.1 *Test A - Static traction stress:* The bar of a mounted apparatus is pulled vertically downwards with a predetermined static tractive force. A measuring device mounted on the bar monitors the displacement - time history of the midpoint of the bar caused by this force. The maximum deflection is recorded with the aid of a data acquisition system. After the release of the static tractive force the bar must return into the starting position.

4.1.2 *Test B - Stress by pendulum swing:* A pendulum which is attached to the bar of a mounted apparatus is rotated from hanging position into horizontal position and then released. While it swings down, an additional falling weight inside the tubular pendulum slides down from a predetermined internal drop height until the weight strikes against the inside bottom of the pendulum, producing an additional impact stress on the gymnastic apparatus. A measuring device monitors the two-dimensional displacement - time history of the midpoint of the bar. Load cells inside both pendulum grasping arms monitor the reaction force - time history of the pendulum. Both are recorded with the aid of a data acquisition system. The test measures the maximum reaction force in the direction of the pendulum's centre of gravity as well as the positive deflection of the bar in vertical direction and the positive and negative deflection of the bar in horizontal direction.

4.1.3 *Test C - Oscillation damping:* A pendulum which is attached to the bar of a mounted apparatus is pulled vertically downwards until a predetermined initial tension is reached. The abrupt release causes a damped oscillation of the bar-pendulum system. A measuring device monitors the displacement - time history of the midpoint of the bar which is recorded with the aid of a data acquisition system. The test measures the frequency as well as the half amplitude interval of the oscillation.

4.2 Static and dynamic data obtained during these procedures are indicative of the static stiffness, elastic, damping, and oscillation properties of the horizontal bar used in training and FIG-sanctioned competitions.

5 Performance Requirements

5.1 *Test A - Static traction stress:* When tested according to the procedures described in Section 9.2, the value of the measured variable shall be within the figures of Table 1.

Table 1: Figure for Test A – Static traction stress
x represents the measured variable

Test A: Static traction stress	
Deflection (mm)	$80 \leq x \leq 100$

5.2 *Test B - Stress by pendulum swing:* When tested according to the procedures described in Section 9.3, the mean values of the measured variables shall be within the figures of Table 2.

Table 2: Figures for Test B – Stress by pendulum swing
x represents the mean value of the measured variable

Test B: Stress by pendulum swing	
F_{max} (N)	$x \leq 3200$
Positive vertical deflection (mm)	$110 \leq x \leq 125$
Negative horizontal deflection (mm)	$-42 \leq x \leq -32$
Positive horizontal deflection (mm)	$56 \leq x \leq 71$

5.3 *Test C - Oscillation damping:* When tested according to the procedures described in Section 9.4, the mean values of the measured variables shall be within the figures of Table 3.

Table 3: Figures for Test C – Oscillation damping
x represents the mean value of the measured variable

Test C: Oscillation damping	
Frequency of oscillation (Hz)	$3.00 \leq x \leq 3.25$
Half amplitude interval (ms)	$1250 \leq x \leq 4900$

6 Test Set-up and Apparatus

6.1 *Set-up for Test A - Static traction stress*: Any type of test set-up is acceptable that is capable to stress the test specimen under prescribed conditions and monitoring and recording the displacement - time history of the midpoint of the bar.

6.2 *Set-up for Test B - Stress by pendulum swing:*

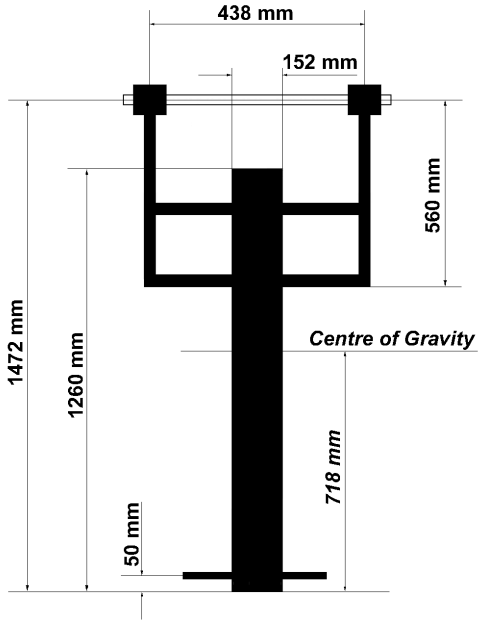
Any type of test set-up is acceptable that is capable of stressing the test specimen with a pendulum swing under prescribed conditions and monitoring and recording the displacement - time history of the midpoint of the bar and the reaction force - time history of the pendulum. It is optional, but desirable, that the pendulum is released from a magnet in the horizontal position.

6.3 *Set-up for Test C - Oscillation damping*: Any type of test set-up is acceptable that is capable of stressing the bar-pendulum system under prescribed conditions and monitoring and recording the displacement - time history of the midpoint of the bar. It is optional, but desirable, that the bar-pendulum system is released from a magnet at the prescribed initial tension.

6.4 *Pendulum* - The pendulum shall meet the following criteria:

6.4.1 *Mass and geometry:* The tubular test body shall have a mass of 40.0 kg ± 3% (including load cells, grasping arms and appliances for additional weights) and a geometry as specified in Figure 3. The load cells shall be located between the test body and the grasping arms. The weight of each grasping arm shall be 1.0 kg ± 3%.

Figure 3: Geometry of Tubular Test Body
(All dimensions with an accuracy of 3%)



6.4.2 *Added weights:* For Test B, two customary 10.0 kg ± 0.1 kg dumb-bell weights shall be added with the help of specific appliances to each side of the pendulum, for an additional weight on the pendulum of 20.0 kg ± 0.2 kg. See Figure 3 for the location of the specific appliances.

6.4.3 *Pendulum fixation* - The pendulum fixation to the bar shall meet the following criteria:

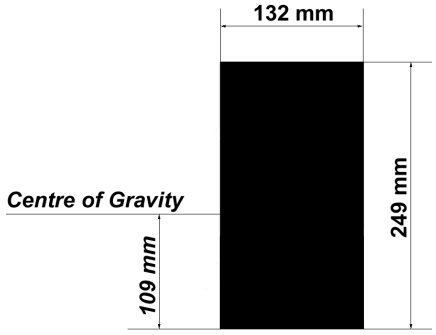
6.4.3.1 *Functional properties:* The fixation shall allow an immediate transfer of forces between pendulum and bar and guarantee a low-friction rotation of the pendulum about the longitudinal axis of the bar (the use of roll bearings is recommended).

6.4.3.2 *Friction of the bar-pendulum fixation* - The frictional properties of the fixation shall meet the following criteria: The time for the pendulum (80 kg: 40 kg pendulum with additional 20 kg falling weight at the inside bottom [no internal drop height] and 20 kg added weights) to swing from horizontal position (release) through hanging (vertical) position shall be 680 ms ± 15 ms.

6.4.4 *Additional falling weight* - The additional falling weight shall meet the following criteria:

6.4.4.1 *Mass and geometry:* The cylindrical falling weight shall have a mass of 20.0 kg ± 0.2 kg and a geometry as specified in Figure 4.

Figure 4: Geometry of Additional Falling Load
(All dimensions with an accuracy of 3%)



6.4.4.2 *Friction within the tube of the test body* - The frictional properties of the additional falling weight shall meet the following criteria: The time for the additional falling weight to cover the internal drop height of 90 cm by a pendulum swing (80 kg) down from horizontal position (release) shall be 640 ms ± 10 ms.

6.4.4.3 *Damping of the additional falling weight at the inside bottom of the tubular test body* - The damping properties of the additional falling weight shall meet the following criteria: The additional falling weight (20 kg) shall produce an average peak force of 5800 N ± 1500 N over 15 impact tests inside the tubular test body with a vertical drop height of 50 mm ± 1 mm. A chloroprene rubber at the bottom of the test body with a thickness of 8 mm, a density of 1.40 g/cm^3 and a tensile strength of 5,5 MPa is re-commended.

6.5 *Recording equipment* - The recording equipment shall meet the following criteria:

6.5.1 *Displacement - time:* The selection of the specific displacement - time recording equipment, including transducers and recorders, is at the discretion of the test laboratory. However, the transducers shall provide linear signals proportional to the two-dimensional displacement of the midpoint of the bar. If displacement is recorded, the test equipment shall have means to determine and record the starting position of the bar from which the total deflections are determined. The total

system, detection and recording, shall be capable of measuring displacements of up to 200 mm at frequencies from 2 to 200 Hz to an accuracy of ± 1%. The minimum sampling rate of the data acquisition system shall be 500 Hz.

6.5.2 *Reaction force - time:* Any reaction force - time recording equipment, including load cells and recorders, which can monitor the reaction force exerted on the pendulum simultaneously with the displacement - time trace is acceptable. The total system, detection and recording, shall be capable of measuring reaction forces of up to 5000 N at frequencies from 2 to 200 Hz to an accuracy of ± 1%. The minimum sampling rate of the data acquisition system shall be 500 Hz.

7 Test Specimen

7.1 The test specimen submitted for testing shall consist of a complete horizontal bar as it is intended to be used during training and/or competition.

7.2 The test specimen shall comply with FIG Apparatus Rules: II-MAG6.

8 Conditioning and Test Temperature

8.1 The horizontal bar, mounted and assembled for use, shall be preconditioned at 50% ± 10% relative humidity and 21° C ± 3° C for a minimum of 24 hours prior to the test. All testing shall be carried out under the same conditions.

9 Laboratory Procedure (Test Method)

9.1 *General set-up:*

9.1.1 Mount the horizontal bar to a height as prescribed for competitions (Part II).

9.1.2 The default cable tension shall be 1500 N ± 50 N provided that there is no other specific cable tension suggested by the manufacturer. If a specific cable tension is suggested by the manufacturer, then this suggested cable tension shall be used.

9.1.3 Install the displacement measuring device on the unloaded bar and determine the starting position.

9.2 *Test A - Static traction stress:*

9.2.1 Pull the midpoint of the bar vertically downwards with a static tractive force of 2200 N ± 20 N and capture, then record the resulting maximum deflection (mm) using recording equipment described in Section 6.5.

9.2.2 After the release of the static tractive force verify whether the bar returns into the starting position.

9.3 *Test B - Stress by pendulum swing:*

9.3.1 Attach the pendulum (80 kg: 40 kg pendulum with additional 20 kg falling weight and 20 kg added weights) to the bar in hanging position.

9.3.2 Move the pendulum from hanging position into horizontal position and move the additional falling weight inside the pendulum to the 90 cm ± 1 cm internal drop height position.

9.3.3 Release the pendulum and capture the two-dimensional displacement - time history of the midpoint of the bar and the reaction force - time history of the pendulum, using recording equipment described in Section 6.5.

9.3.4 Stress the horizontal bar by repeating the pendulum swing five times.

9.3.5 Immediately following each test, record the following measurements: F_{max} (N), positive vertical deflection (mm), as well as positive and negative horizontal deflection (mm).

9.3.6 All five tests shall be used to determine the arithmetic mean value of each measured variable.

9.3.7 Repeat the measurements in 9.3.1 to 9.3.6 for all possibly allowed changes in height of the stands according to Part II of the FIG Apparatus Norms.

9.4 *Test C - Oscillation damping:*

9.4.1 Attach the pendulum (60 kg: 40 kg pendulum with additional 20 kg falling weight at the inside bottom of the pendulum) to the bar in hanging position.

9.4.2 Pull down the pendulum vertically until the initial tension of 1000 N ± 30 N is reached.

9.4.3 Release the pendulum and capture the displacement - time history of the midpoint of the bar using recording equipment described in Section 6.5.

9.4.4 Repeat the above process five times.

9.4.5 Immediately following each test, record the following measurements: Frequency (Hz) and half amplitude interval (ms) of the oscillation.

9.4.6 All five tests shall be used to determine the arithmetic mean value of each measured variable.

9.5 Calculate the values of all required variables rounded to the decimal places of the corresponding figures identified in Section 5.

10 Report

10.1 *The test report shall include the following information:*

10.1.1 Complete identification of the tested horizontal bar, including type, source, manufacturer's model number (if appropriate), dimensions of test specimen, and any other pertinent information. Photographs may be included in the test report for sample documentation purposes.

10.1.2 Test identification number according to the internal regulations between the FIG Test Institutes.

10.1.3 Complete identification of the testing laboratory including test technician and test laboratory manager (if appropriate).

10.1.4 Conditions of test, including test date, temperature and humidity.

10.1.5 Test height and cable tension of the unloaded horizontal bar.

10.1.6 *Test A - Static traction stress:* Description of the static tractive force.

10.1.7 *Test B - Stress by pendulum swing:* Description of the pendulum mass with added weights, the additional falling weight and the internal drop height.

10.1.8 *Test C - Oscillation damping:* Description of the pendulum mass (including the additional falling weight at the inside bottom of the pendulum) and the initial tension.

10.1.9 Description of the test results relative to the performance requirements identified in Section 5.

FIG International Gymnastics Federation
Standard Specification for 20 cm Landing Mats
MAG – Men Artistic Gymnastics

This standard is subject to revision at any time by the FIG Apparatus Commission. You are invited to comment on revision of this standard or on additional standards. Comments should be addressed to the FIG General Secretary.

Standard Specification: 20 cm Landing Mats for Men Artistic Gymnastics

This standard is issued under the fixed designation FIG: IV-MAG11-01.08.1996; the numbers immediately following the designation indicate the date of original adoption by the FIG, or, in case of revision, the date of the last revision. This FIG standard was prepared by the Apparatus Commission of the FIG and participating FIG test laboratories. This standard was originally published in English only.

Introduction

The objective of this FIG standard is to provide equal opportunities for all athletes in FIG competitions by controlling the functional properties of landing mats and to minimize any differences between competition and training equipment.

1 Scope

1.1 This specification covers the measurement of certain shock-absorbing characteristics, the impact force - time relationships, and the rebound properties of 20 cm landing mats. This standard specification is applicable to all landing mat systems that are to be used at any FIG-sanctioned event.

1.2 This specification does not imply that an injury cannot be incurred while using a landing mat system which complies with this specification.

1.3 The test procedures associated with this standard may involve hazardous operations and equipment. This standard does not purport to address all the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to use.

2 Normative References

2.1 Society of Automotive Engineers: SAE J211 Recommended Practice for Instrumentation for Impact Tests – Requirements for Channel Class 1000, October 1988.

2.2 International Gymnastics Federation (FIG): Apparatus Rules: II-MAG11.

3 Terminology

3.1 *Description of terms specific to this standard:*

3.1.1 *Acceleration:* The instantaneous time rate of change of velocity, expressed in m/s^2, which may be positive or negative.

3.1.2 *Base plane:* The starting reference plane of the landing mat system from which the total deflection and total height of rebound is determined. It is taken as the top plane of the landing mat system.

3.1.3 *Deflection:* The measured distance (in mm) between the base plane and the maximum displacement of the impactor below the base plane.

3.1.4 *Force (F):* The product of the mass of the impactor, expressed in kg, and the acceleration of the impactor, expressed in m/s^2.

3.1.5 *Maximum Force (F_{max}):* The maximum value of force measured during the impact and expressed in Newtons.

3.1.6 *Height of rebound:* The measured distance (in mm) between the base plane and the maximum displacement of the impactor above the base plane.

3.1.7 *Impactor:* The striking part of the test apparatus.

3.1.8 *Impact velocity:* The velocity of the impactor, expressed in m/s, immediately prior to crossing the base plane on impact.

3.1.9 *Theoretical drop height:* A calculated drop height which equates the measured velocity of the impactor at the moment of impact to a height that would generate the same velocity if the test were performed at sea level and there was no friction to retard the impactor during a drop from that height.

4 Principle of Measurement

4.1 A test specimen is impacted at a specified velocity with an impactor of given mass and geometry. A transducer mounted in the impactor monitors the acceleration – time history of the impactor which is recorded with the aid of a data acquisition system. An additional transducer may be used to monitor the displacement – time history of the impactor.

4.2 Dynamic data obtained during these procedures are indicative of the cushioning and rebound properties of the landing mat systems and materials used in training and FIG-sanctioned competitions.

5 Performance Requirements

5.1 When tested according to the procedures described in Section 9, the overall mean values of the measured variables across all impact sites shall be within the figures of Table 1.

Table 1: Figures for 20 cm Landing Mats

Deflection (mm)	***Height of rebound (mm)***	***F_{max} (N)***
≤ 110	≤ 90	≤ 3000

6 Test Apparatus

6.1 *Impact test machine:* Any type of dynamic testing apparatus that is capable of impacting a test specimen at a prescribed impact velocity and monitors and records the acceleration - time history of the impactor is acceptable. The impact test machine and the impactor shall have sufficient rigidity to eliminate undesirable vibrations in the apparatus which might be recorded on the acceleration - time curve. The impact test machine

shall also be designed in such a manner that only the impact face of the impactor contacts the test specimen at any time during the test procedures.

6.2 *Impactor:* The impactor shall be 20 kg ± 0.2 kg and shall have a flat impact face with a 10 cm ± 0.5 cm diameter. The edge of the impactor face should be relieved to eliminate sharp edges. Provision shall be made so that the accelerometer can be securely fastened parallel to the vertical axis of the impactor with a maximum deviation of ± 5°.

6.3 *Recording equipment - The recording equipment shall meet the following criteria:*

6.3.1 *Acceleration - time:* The selection of the specific acceleration - time recording equipment, including transducers and recorders, is at the discretion of the test laboratory. However, the recording system shall have a frequency response adequate to measure the peak acceleration value to an accuracy of ± 5% of the true value. The total system, detection and recording, shall be capable of measuring impact accelerations of up to 200 g at frequencies from 2 to 1000 Hz to an accuracy of ± 5%. The minimum sampling rate of the data acquisition system shall be 5000 Hz.

6.3.2 *Displacement - time:* It is optional, but desirable, that the displacement - time history is recorded by a separate transducer. Any transducer that provides a linear signal proportional to the displacement of the impactor along the impact axis which can be monitored simultaneously with the acceleration - time trace is acceptable. If displacement is recorded, the test equipment shall have means to determine and record the top plane (base plane) of the test specimen from which the total deformation and rebound height are determined.

6.3.3 *Filtering:* The signal from all transducers shall be conditioned with a low pass filter which complies with Channel Class 1000 of SAE Recommended Practice J211. A fourth-order Butterworth low pass filter with a cut-off frequency of 1000 Hz meets this requirement.

7 Test Specimen

7.1 The test specimen submitted for testing shall represent the landing mat as it is intended to be used during training and/or competition.

7.2 The test specimen shall comply with FIG Apparatus Rules: II-MAG11. Exception: See 7.3.

7.3 The minimum horizontal dimensions (length * width) for any test specimen shall be 200 cm * 120 cm.

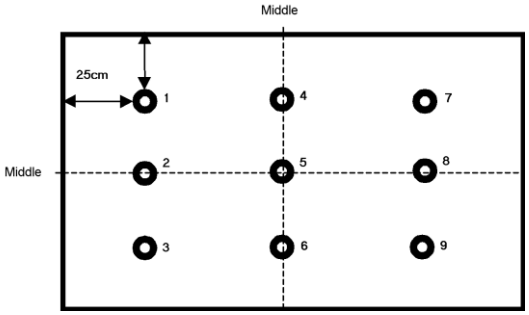
8 Conditioning and Test Temperature

8.1 Test specimens shall be preconditioned at 50% ± 10% relative humidity and 21° C ± 3° C for a minimum of 24 hours prior to the test. All testing shall be carried out under the same conditions.

9 Laboratory Procedure (Test Method)

9.1 *Impact locations:* A total of nine impact sites shall be designated on the test specimen. See Figure 1 for an illustration of the impact sites.

Figure 1: Impact Locations for Landing Mats



9.2 *Impact test procedures:*

9.2.1 Place the test specimen under the impact test machine on a smooth, solid floor (concrete or metal plate) and orient the impactor such that the centre of the impact face will contact one of the designated impact test sites.

9.2.2 Raise the impactor to an appropriate drop height such that it will contact the test specimen with an impact velocity of 3.96 m/s ± 3%. This corresponds to a theoretical drop height of 0.8 m.

9.2.3 Release the impactor and capture the acceleration - time history and displacement - time history (if applicable) using recording equipment described in Section 6.3.

9.2.4 Upon completion of a given impact test, raise the impactor off the surface of the test specimen.

9.2.5 The duration between tests at a given impact site shall not be less than 120 seconds.

9.2.6 Each test specimen shall receive a total of 90 impacts. Impact each of the nine impact sites ten times.

9.3 *Calculations:*

9.3.1 Immediately following each test, record the following measurements: F_{max} (N), Deflection (mm) and Height of rebound (mm).

9.3.2 The last eight tests for each impact site shall be used to determine the arithmetic mean value of a measured variable for each impact site and for the overall mean value of a measured variable across all impact sites.

9.3.3 Calculate the mean values of Deflection, Height of rebound and F_{max} across all impact sites rounded to zero decimal places.

10 Report

10.1 *The test report shall include the following information:*

10.1.1 Complete identification of the tested landing mat, including type, source, manufacturer's model number (if appropriate), dimensions of test specimen, and any other pertinent information. Photographs may be included in the test report for sample documentation purposes.

10.1.2 Test identification number according to the internal regulations between the FIG Test Institutes.

10.1.3 Complete identification of the testing laboratory including test technician and test laboratory manager (if appropriate).

10.1.4 Conditions of test, including test date, temper-

ature and humidity.

10.1.5 Description of the impactor mass and the drop height conditions.

10.1.6 Description of the test results relative to the performance requirements identified in Section 5.

10.1.7 Mean values of Deflection, Height of rebound and F_{max} across all impact sites.

10.1.8 Maximum value, minimum value and standard deviation of Deflection, Height of rebound and F_{max} variables.

10.1.9 Mean values of Deflection, Height of rebound and F_{max} for the last eight tests at each impact site.

10.1.10 Deflection, Height of rebound and F_{max} values for all tests.

This standard is subject to revision at any time by the FIG Apparatus Commission. You are invited to comment on revision of this standard or on additional standards. Comments should be addressed to the FIG General Secretary.

Standard Specification: 10 cm Landing Mats for Men Artistic Gymnastics

This standard is issued under the fixed designation FIG: IV-MAG12-12.07.1989; the numbers immediately following the designation indicate the date of original adoption by the FIG, or, in case of revision, the date of the last revision. This FIG standard was prepared by the Apparatus Commission of the FIG and participating FIG test laboratories. This standard was originally published in English only.

Introduction

The objective of this FIG standard is to provide equal opportunities for all athletes in FIG competitions by controlling the functional properties of landing mats and to minimize any differences between competition and training equipment.

1 Scope

1.1 This specification covers the measurement of certain shock-absorbing characteristics, the impact force - time relationships, and the rebound properties of 10 cm landing mats. This standard specification is applicable to all landing mat systems that are to be used at any FIG-sanctioned event.

1.2 This specification does not imply that an injury cannot be incurred while using a landing mat system which complies with this specification.

1.3 The test procedures associated with this standard may involve hazardous operations and equipment. This standard does not purport to address all the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to use.

2 Normative References

2.1 Society of Automotive Engineers: SAE J211 Recommended Practice for Instrumentation for Impact Tests – Requirements for Channel Class 1000, October 1988.

2.2 International Gymnastics Federation (FIG): Apparatus Rules: II-MAG12.

3 Terminology

3.1 *Description of terms specific to this standard:*

3.1.1 *Acceleration:* The instantaneous time rate of change of velocity, expressed in m/s^2, which may be positive or negative.

3.1.2 *Base plane:* The starting reference plane of the landing mat system from which the total deflection and total height of rebound is determined. It is taken as the top plane of the landing mat system.

3.1.3 *Deflection:* The measured distance (in mm) between the Base plane and the maximum displacement of the impactor below the Base plane.

3.1.4 *Force (F):* The product of the mass of the impactor, expressed in kg, and the acceleration of the impactor, expressed in m/s^2.

3.1.5 *Maximum Force (F_{max}):* The maximum value of force measured during the impact and expressed in Newtons.

3.1.6 *Height of rebound:* The measured distance (in mm) between the Base plane and the maximum displacement of the impactor above the Base plane.

3.1.7 *Impactor:* The striking part of the test apparatus.

3.1.8 *Impact velocity:* The velocity of the impactor, expressed in m/s, immediately prior to crossing the base plane on impact.

3.1.9 *Theoretical drop height:* A calculated drop height which equates the measured velocity of the impactor at the moment of impact to a height that would generate the same velocity if the test were performed at sea level and there was no friction to retard the impactor during a drop from that height.

4 Principle of Measurement

4.1 A test specimen is impacted at a specified velocity with an impactor of given mass and geometry. A transducer mounted in the impactor monitors the acceleration – time history of the impactor which is recorded with the aid of a data acquisition system. An additional transducer may be used to monitor the displacement – time history of the impactor.

4.2 Dynamic data obtained during these procedures are indicative of the cushioning and rebound properties of the landing mat systems and materials used in training and FIG-sanctioned competitions.

5 Performance Requirements

5.1 When tested according to the procedures described in Section 9, the overall mean values of the measured variables across all impact sites shall be within the figures of Table 1.

Table 1: Figures for 10 cm Landing Mats

Deflection (mm)	***Height of rebound (mm)***	***F_{max} (N)***
≤ 65	≤ 80	≤ 3750

6 Test Apparatus

6.1 *Impact test machine:* Any type of dynamic testing apparatus that is capable of impacting a test specimen at a prescribed impact velocity and monitoring and recording the acceleration - time history of the impactor is acceptable. The impact test machine and the impactor shall have sufficient rigidity to eliminate undesirable vibrations in the apparatus which might be recorded on the acceleration - time curve. The impact test machine shall also be designed in such a manner that only the impact face of the impactor contacts the test specimen at any time during the test procedures.

6.2 *Impactor:* The impactor shall be 20 kg ± 0.2 kg and shall have a flat impact face with a 10 cm ± 0.5 cm diameter. The edge of the impactor face should be re-

lieved to eliminate sharp edges. Provision shall be made so that the accelerometer can be securely fastened parallel to the vertical axis of the impactor with a maximum deviation of ± 5º.

6.3 *Recording equipment - The recording equipment shall meet the following criteria:*

6.3.1 *Acceleration - time:* The selection of the specific acceleration - time recording equipment, including transducers and recorders, is at the discretion of the test laboratory. However, the recording system shall have a frequency response adequate to measure the peak acceleration value to an accuracy of ± 5% of the true value. The total system, detection and recording, shall be capable of measuring impact accelerations of up to 200 g at frequencies from 2 to 1000 Hz to an accuracy of ± 5%. The minimum sampling rate of the data acquisition system shall be 5000 Hz.

6.3.2 *Displacement - time:* It is optional, but desirable, that the displacement - time history is recorded by a separate transducer. Any transducer that provides a linear signal proportional to the displacement of the impactor along the impact axis which can be monitored simultaneously with the acceleration - time trace is acceptable. If displacement is recorded, the test equipment shall have means to determine and record the top plane (base plane) of the test specimen from which the total deformation and rebound height are determined.

6.3.3 *Filtering:* The signal from all transducers shall be conditioned with a low pass filter which complies with Channel Class 1000 of SAE Recommended Practice J211. A fourth-order Butterworth low pass filter with a cut-off frequency of 1000 Hz meets this requirement.

7 Test Specimen

7.1 The test specimen submitted for testing shall represent the landing mat as it is intended to be used during training and/or competition.

7.2 The test specimen shall comply with FIG Apparatus Rules: II-MAG12. Exception: See 7.3.

7.3 The minimum horizontal dimensions (length * width) for any test specimen shall be 200 cm * 120 cm.

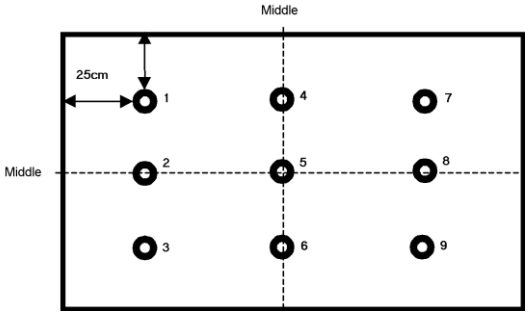
8 Conditioning and Test Temperature

8.1 Test specimens shall be preconditioned at 50% ± 10% relative humidity and 21º C ± 3º C for a minimum of 24 hours prior to the test. All testing shall be carried out under the same conditions.

9 Laboratory Procedure (Test Method)

9.1 *Impact locations:* A total of nine impact sites shall be designated on the test specimen. See Figure 1 for an illustration of the impact sites.

Figure 1: Impact Locations for Landing Mats



9.2 *Impact test procedures:*

9.2.1 Place the test specimen under the impact test machine on a smooth, solid floor (concrete or metal plate) and orient the impactor such that the centre of the impact face will contact one of the designated impact test sites.

9.2.2 Raise the impactor to an appropriate drop height such that it will contact the test specimen with an impact velocity of 2.80 m/s +/- 3%. This corresponds to a theoretical drop height of 0.4 m.

9.2.3 Release the impactor and capture the acceleration - time history and displacement - time history (if applicable) using recording equipment described in Section 6.3.

9.2.4 Upon completion of a given impact test, raise the impactor off the surface of the test specimen.

9.2.5 The duration between tests at a given impact site shall not be less than 120 seconds.

9.2.6 Each test specimen shall receive a total of 90 impacts. Impact each of the nine impact sites ten times.

9.3 *Calculations:*

9.3.1 Immediately following each test, record the following measurements: F_{max} (N), Deflection (mm) and Height of rebound (mm).

9.3.2 The last eight tests for each impact site shall be used to determine the arithmetic mean value of a measured variable for each impact site and for the overall mean value of a measured variable across all impact sites.

9.3.3 Calculate the mean values of Deflection, Height of rebound and F_{max} across all impact sites rounded to zero decimal places.

10 Report

10.1 *The test report shall include the following information:*

10.1.1 Complete identification of the tested landing mat, including type, source, manufacturer's model number (if appropriate), dimensions of test specimen, and any other pertinent information. Photographs may be included in the test report for sample documentation purposes.

10.1.2 Test identification number according to the internal regulations between the FIG Test Institutes.

10.1.3 Complete identification of the testing laboratory including test technician and test laboratory manager (if appropriate).

10.1.4 Conditions of test, including test date, temper-

ature and humidity.

10.1.5 Description of the impactor mass and the drop height conditions.

10.1.6 Description of the test results relative to the performance requirements identified in Section 5.

10.1.7 Mean values of Deflection, Height of rebound and F_{max} across all impact sites.

10.1.8 Maximum value, minimum value and standard deviation of Deflection, Height of rebound and F_{max} variables.

10.1.9 Mean values of Deflection, Height of rebound and F_{max} for the last eight tests at each impact site.

10.1.10 Deflection, Height of rebound and F_{max} values for all tests.

This standard is subject to revision at any time by the FIG Apparatus Commission. You are invited to comment on revision of this standard or on additional standards. Comments should be addressed to the FIG General Secretary.

Standard Specification: Vaulting Boards for Men Artistic Gymnastics

This standard is issued under the fixed designation FIG: IV-MAG14-01.01.2015; the numbers immediately following the designation indicate the date of original adoption by the FIG, or, in case of revision, the date of the last revision. This FIG standard was prepared by the Apparatus Commission of the FIG and participating FIG test laboratories. This standard was originally published in English only.

Introduction

The objective of this FIG standard is to provide equal opportunities for all athletes in FIG competitions by controlling the functional properties of vaulting boards and to minimize any differences between competition and training equipment.

1 Scope

1.1 This specification covers the measurement of certain shock-absorbing characteristics, the impact force - time relationships, and the rebound properties of vaulting boards. This standard specification is applicable to all vaulting boards that are to be used at any FIG-sanctioned event.

1.2 This specification does not imply that an injury cannot be incurred while using a vaulting board which complies with this specification.

1.3 The test procedures associated with this standard may involve hazardous operations and equipment. This standard does not purport to address all the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to use.

2 Normative References

2.1 Society of Automotive Engineers: SAE J211 Recommended Practice for Instrumentation for Impact Tests – Requirements for Channel Class 1000, October 1988.

2.2 International Gymnastics Federation (FIG): Apparatus Rules: II-MAG14.

3 Terminology

3.1 *Description of terms specific to this standard:*

3.1.1 *Acceleration:* The instantaneous time rate of change of velocity, expressed in m/s^2, which may be positive or negative.

3.1.2 *Starting position of an impact site:* The vertical position of an impact site at the surface of an unloaded vaulting board from which the total deflection and total height of rebound is determined.

3.1.3 *Deflection:* The measured distance (in mm) between the starting position of an impact site and the maximum displacement of the impactor below the starting position of an impact site.

3.1.4 *Force (F):* The product of the mass of the impactor, expressed in kg, and the acceleration of the impactor, expressed in m/s^2.

3.1.5 *Maximum Force (F_{max}):* The maximum value of force measured during the impact and expressed in Newtons.

3.1.6 *Height of rebound:* The measured distance (in mm) between the starting position of an impact site and the maximum displacement of the impactor above the starting position of an impact site.

3.1.7 *Impactor:* The striking part of the test apparatus.

3.1.8 *Impact velocity:* The velocity of the impactor, expressed in m/s, immediately prior to crossing the starting position of an impact site on impact.

3.1.9 *Theoretical drop height:* A calculated drop height which equates the measured velocity of the impactor at the moment of impact to a height that would generate the same velocity if the test were performed at sea level and there was no friction to retard the impactor during a drop from that height.

4 Principle of Measurement

4.1 A test specimen is impacted at a specified velocity with an impactor of given mass and geometry. A transducer mounted in the impactor monitors the acceleration – time history of the impactor which is recorded with the aid of a data acquisition system. An additional transducer may be used to monitor the displacement – time history of the impactor.

4.2 Dynamic data obtained during these procedures are indicative of the cushioning and rebound properties of the vaulting board used in training and FIG-sanctioned competitions.

5 Performance Requirements

5.1 When tested according to the procedures described in Section 9, the overall mean values of the measured variables and the differences of the mean values at specified impact sites shall be within the figures of Table 1.

Table 1: Figures for the "hard" Vaulting Boards
See Figure 1 for an illustration of the impact sites. X represents the overall mean value of the measured variable.

	Deflection (mm)	***Height of rebound (mm)***	***F_{max} (N))***
Mean value across impact sites 1 to 5	55 ≤ x ≤ 68	340 ≤ x ≤ 400	x ≤ 4000
Difference between highest and lowest mean value on impact sites 1 to 5	≤ 15	≤ 100	
Difference between mean value on impact sites 6 and 7	≤ 4	≤ 25	≤ 150

Table 2: Figures for the "soft" Vaulting Boards
See Figure 1 for an illustration of the impact sites. X represents the overall mean value of the measured variable.

	Deflection (mm)	***Height of rebound (mm)***	***F_{max} (N))***
Mean value across impact sites 1 to 5	62 ≤ x ≤ 80	340 ≤ x ≤ 400	x ≤ 4000
Difference between highest and lowest mean value on impact sites 1 to 5	≤ 15	≤ 100	
Difference between mean value on impact sites 6 and 7	≤ 4	≤ 25	≤ 150

6 Test Apparatus

6.1 *Impact test machine:* Any type of dynamic testing apparatus that is capable of impacting a test specimen at a prescribed impact velocity and monitoring and recording the acceleration - time history of the impactor is acceptable. The impact test machine and the impactor shall have sufficient rigidity to eliminate undesirable vibrations in the apparatus which might be recorded on the acceleration - time curve. The impact test machine shall also be designed in such a manner that only the impact face contacts the test specimen at any time during the test procedures.

6.2 *Impactor:* The impactor shall be 20 kg ± 0.2 kg and shall have a flat impact face with a 10 cm ± 0.5 cm diameter. The edge of the impactor face should be relieved to eliminate sharp edges. Provision shall be made so that the accelerometer can be securely fastened parallel to the vertical axis of the impactor with a maximum deviation of ± 5º.

6.3 *Recording equipment - The recording equipment shall meet the following criteria:*

6.3.1 *Acceleration - time:* The selection of the specific acceleration - time recording equipment, including transducers and recorders, is at the discretion of the test laboratory. However, the recording system shall have a frequency response adequate to measure the peak acceleration value to an accuracy of ± 5% of the true value. The total system, detection and recording, shall be capable of measuring impact accelerations of up to 200 g at frequencies from 2 to 1000 Hz to an accuracy of ± 5%. The minimum sampling rate of the data acquisition system shall be 5000 Hz.

6.3.2 *Displacement - time:* It is optional, but desirable, that the displacement - time history is recorded by a separate transducer. Any transducer that provides a linear signal proportional to the displacement of the impactor along the impact axis which can be monitored simultaneously with the acceleration - time trace is acceptable. If displacement is recorded, the test equipment shall have means to determine and record the starting position of an impact site of the test specimen from which the total deformation and rebound height are determined.

6.3.3 *Filtering:* The signal from all transducers shall be conditioned with a low pass filter which complies with Channel Class 1000 of SAE Recommended Practice J211. A fourth-order Butterworth low pass filter with a cut-off frequency of 1000 Hz meets this requirement.

7 Test Specimen

7.1 The test specimen submitted for testing shall consist of a vaulting board and its associated safety collar as it is intended to be used during training and/or competition.

7.2 The test specimen shall comply with FIG Apparatus Rules: II-MAG14.

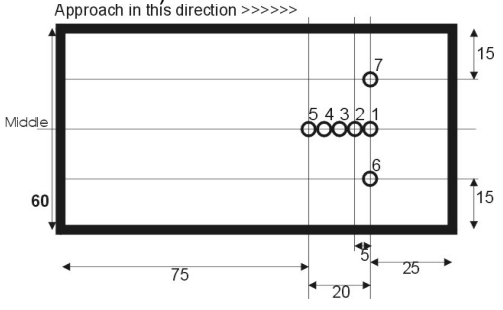
8 Conditioning and Test Temperature

8.1 The test specimen shall be preconditioned at 50% ± 10% relative humidity and 21º C ± 3º C for a minimum of 24 hours prior to the test. All testing shall be carried out under the same conditions.

9 Laboratory Procedure (Test Method)

9.1 *Impact locations:* A total of seven impact sites shall be designated on the test specimen. See Figure 1 for an illustration of the impact sites.

Figure 1: Impact Locations for Vaulting Boards
(Dimensions in cm)



9.2 *Impact test procedures:*

9.2.1 Place the test specimen under the impact test machine on a smooth, solid floor (concrete or metal plate) and orient the impactor such that the centre of the impact face will contact one of the designated impact test sites.

9.2.2 Raise the impactor to an appropriate drop height such that it will contact the test specimen with an impact velocity of 3.96 m/s ± 3%. This corresponds to a theoretical drop height of 0.8 m.

9.2.3 Release the impactor and capture the acceleration - time history and displacement - time history (if applicable) using recording equipment described in Section 6.3.

9.2.4 Upon completion of a given impact test, raise the impactor off the surface of the test specimen.

9.2.5 The duration between tests at a given impact site shall not be less than 30 seconds.

9.2.6 Each test specimen shall receive a total of 70 impacts. Impact each of the seven impact sites ten times.

9.3 *Calculations:*

9.3.1 Immediately following each test, record the following measurements: F_{max} (N), Deflection (mm) and Height of rebound (mm).

9.3.2 The last eight tests for each impact site shall be used to determine the arithmetic mean value of a measured variable for each measurement point.

9.3.3 Calculate the mean values of Deflection, Height of rebound and F_{max} across all impact sites rounded to zero decimal places.

10 Report

10.1 *The test report shall include the following information:*

10.1.1 Complete identification of the tested vaulting board, including type, source, manufacturer's model number (if appropriate), dimensions of test specimen, and any other pertinent information. Photographs may be included in the test report for sample documentation purposes.

10.1.2 Test identification number according to the internal regulations between the FIG Test Institutes.

10.1.3 Complete identification of the testing laboratory including test technician and test laboratory manager (if appropriate).

10.1.4 Conditions of test, including test date, temperature and humidity.

10.1.5 Description of the impactor mass and the drop height conditions.

10.1.6 Description of the test results relative to the performance requirements identified in Section 5.

10.1.7 Mean values of Deflection, Height of rebound and F_{max} across impact sites 1 to 5.

10.1.8 Maximum value, minimum value and standard deviation of Deflection, Height of rebound and F_{max} variables for impact sites 1 to 5.

10.1.9 Mean values of Deflection, Height of rebound and F_{max} for the last eight tests at each impact site.

10.1.10 Deflection, Height of rebound and F_{max} values for all tests.

Standard Specification: Tension Control Sensors (TCS) for Rings, High Bars and Uneven Bars for MAG WAG Competitions

This standard is issued under the fixed designation FIG: IV-MAGWAG 18 1.9.2019; the numbers immediately following the designation indicate the date of original adoption by the FIG, or, in case of revision, the date of the last revision. This FIG standard was prepared by the Apparatus Commission of the FIG and participating FIG test laboratories. This standard was originally published in English only.

Introduction

The objective of this FIG standard is to provide equal opportunities for all athletes in FIG competitions by controlling the functional properties of Tension Control Sensors (TCS) intended to be used by men's and women's artistic gymnastics competitions.

1 Scope

1.1 This specification covers the technical control of the sensor and the measurement display of a TCS. This standard specification is applicable to all TCS that are to be used at any FIG-sanctioned event.

1.2 This specification does not imply that an injury cannot be incurred while using a TCS which complies with this specification.

1.3 The test procedures associated with this standard may involve hazardous operations and equipment. This standard does not purport to address all the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to use.

2 Normative References

2.1 International Gymnastics Federation (FIG): Apparatus Norms; Part II – MAG18 / WAG18

3 Terminology

Description of terms specific to this standard:

3.1 *Tension:* Non-negative, one-dimensional pulling force transmitted by means of a cable, chain or a rod measured in Newtons.

3.2 *Reference tensiometer:* Calibrated electronic device capable of measuring given tensions in a suitable test apparatus.

4 Principle of the Test

The test procedure consists of repeated measurements in which the test specimen is tested under specified tensions by the use of a suitable test apparatus. The actual applied tension is controlled by a reference tensiometer series-connected with the test specimen and the displayed values of the TCS are compared with those of the reference tensiometer. The deviations are indicative for the precision of the TCS during training and FIG sanctioned competitions.

5 Performance Requirements

When tested according to the procedures described in section 9. the maximal, absolute deviation between the rounded data displayed by the TCS and the data given by the reference tensiometer shall not be greater than 100 N.

6 Test Apparatus

6.1 *Test set-up:* Any type of test set-up that is capable of loading a TCS with mechanical tensions between 0 and 5000 Newtons under the prescribed conditions and monitoring the real tension by a reference tensiometer is acceptable.

6.2 *Reference tensiometer:* It is at the discretion of the test laboratory to select a specific instrumentation to monitor, record and determine the reference tension in the test apparatus. The calibrated reference tensiometer shall be capable of measuring with an accuracy lower than ± 50 N within the range of 0 – 10000 N.

6.3. *Possible correction due to the weight of the TCS and or the reference tensiometer:* If the weights of the reference tensiometer, the test specimen or the tensioning devices used (chains, wire ropes, shackles, tension changing devices, etc.) have an influence on the comparability of the data between the TCS and reference tensiometer (due to the installation situation), the data read off shall be corrected mathematically accordingly.

7 Equipment which has to be submitted for testing

7.1 The test specimen submitted for testing shall represent the TCS with all hard- and software as it is intended to be used during training and/or competition for the indication of the tension in the tensioning ropes at Uneven Bars, High Bar or Ring Frames. The submission shall furthermore include the following parts:

7.2 Additional components for a calibration procedure, if necessary.

7.3 A suitable charging device must be included with the TCS. If this is not the case, it must be documented how the users are informed about the equipment necessary for the intended use (charger, power bank, etc.).

7.4 The test specimen shall comply with *MAG18 and WAG18 of FIG Apparatus Norms Part II*.

7.5 All components (soft- and hardware) shall be submitted with a full technical documentation and all necessary technical descriptions (including installation procedures) written in English.

7.6 Confirmation that all load-bearing mechanical components of the TCS (screws, shackles, load cell etc.) are designed and rated for a breaking load of at

least 15000 N.

8 Conditioning and Test Temperature

Test specimens shall be preconditioned at 50% ± 10% relative humidity and 21° C ± 3° C for a minimum of 24 hours prior to the test. All testing shall be carried out under the same conditions.

9 Laboratory Procedure

9.1 *Tension test procedure:* Install the TCS in the test apparatus and perform one measurement for each specified range in the following table. For the setting of a value within the respective range, the reading of the reference tensiometer is decisive.

Tension values for TCS

tension test number	tension range value [N]
1	0 ≤ x < 50
2	190 ≤ x < 290
3	450 ≤ x < 550
4	710 ≤ x < 810
5	950 ≤ x < 1050
6	1190 ≤ x < 1290
7	1450 ≤ x < 1550
8	1710 ≤ x < 1810
9	1950 ≤ x < 2050
10	2190 ≤ x < 2290
11	2450 ≤ x < 2550
12	2710 ≤ x < 2810
13	2950 ≤ x < 3050
14	3190 ≤ x < 3290
15	3450 ≤ x < 3550
16	3710 ≤ x < 3810
17	3950 ≤ x < 4050
18	4190 ≤ x < 4290
19	4450 ≤ x < 4550
20	4710 ≤ x < 4810
21	4950 ≤ x < 5050
22	5050 ≤ x < 5150

9.2 Check and monitor the recordings of the TCS and the reference tensiometer for every test. It must be ensured that no disturbing vibrations or other strange occurrences appear during the test. Stop the test series immediately if any cracks occur in the test specimen or unexpected irregularities occur in the measured values.

9.3 Repeat the test procedures until all 26 tension measurements have been recorded.

9.4 Calculations: For each prescribed test calculate the deviation $d_{i\ (i:1..26)}$ between the given data from the reference tensiometer and the reported result from the TCS. Determine the maximal absolute deviation max $|d_i|$ in Newtons.

10 Report

The test report shall include the following information:

10.1 Complete identification of the tested TCS, including type, source, manufacturer's model number (if available) and any other pertinent information. Photographs may be included in the test report for sample documentation purposes.

10.2 Test identification number according to the internal regulations between the FIG Test Institutes.

10.3 Complete identification of the testing laboratory including test technician and test laboratory manager (if available).

10.4 Conditions of test, including test date, temperature and humidity.

10.5 Description of the test results relative to the performance requirements identified in section 5.

Apparatus Control Forms MAG (Form B)

(for forms A: see FIG Apparatus Norms Part III)

Prior to every FIG Event in MAG an apparatus control shall be scheduled before the first contact of athletes with the equipment. The completed forms have to be reported to the TC President or if he is not at the competitions site to the FIG Event Delegate and to the President of the FIG Apparatus Commission. According to the FIG event, different forms shall be used:

Form A: (FIG TC Delegate)
Competitions: World Cups, Continental Games (without FIG Apparatus Commissioner)

Main aspects for the apparatus control with form A:

- To be performed 1-2 h prior to the first contact of the athletes with the equipment.
- To be done for training hall (every set), warming up hall and competition hall.
- Control of specifications of the FIG Apparatus Manual.
- Judgment of non-described safety relevant aspects.
- Control of all adjustable heights, lengths etc. at the apparatuses.
- Control of all security relevant parts (fixings, stability and mats displacement).
  Control of the proper installation and functional utilitability of the apparatuses and mats.
- If necessary monitoring of apparatus relevant ad hoc decisions of the TP / TC or other FIG Authorities.

Remark: Forms A are published in FIG Apparatus Norms Part III.

Form(s) B: (FIG Apparatus Commissioner)
Competitions: World Championships and Olympic Games (with FIG Apparatus Commissioner)

Main aspects for the apparatus control with forms B:

(IC) Intensive Control (FIG Apparatus Commissioner):
- To be done for training hall (every set), warming up hall and competition hall
- To be performed prior to the first contact of the athletes with the equipment
- Control of accordance of equipment with the tested Specimen
- Control of all specifications of the FIG Apparatus Manual
- Judgment of non-described safety relevant aspects
- Report of the results to the Technical President
- If necessary, monitoring of apparatus relevant ad hoc decisions of the TP / TC or other FIG Authorities

(FC) Final Control (Technical Committee Member(s), FIG Apparatus Commissioner):
- To be performed immediately prior to the competition or the podium training.
- Control of all adjustable heights, lengths etc. at the apparatuses.
- Control of all security relevant parts (fixings, stability and mats displacement).

(LC) Daily Light Control (FIG Apparatus Commissioner):
- To be performed every day in all training and warming up halls.
- Control of accordance of the equipment with the time of the extensive control.
- Control of all adjustable heights, lengths etc. at the apparatuses.
- Control of all security relevant parts (fixings, stability and mats displacement).

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Apparatus Control MAG
(Final Control - Forms B)
(Forms A: see FIG Apparatus Norms Part III)

APPARATUS CONTROL B (IC) - MEN'S ARTISTIC GYMNASTICS

Competition Logo

Competition: ***Name of the Competition***

Discipline: **MAG**	Site:	Date:

General intensive Control (FIG Apparatus Manager)		
MAG1 Floor	**Stipulation**	**Result - Action**
Concordance with test report:		
Surface area	width A (1200 ± 3 cm)	
	width B (1200 ± 3 cm)	
	diagonal (1697 ± 5 cm)	
horizontal, even, without gaps		
Border	horizontal (100cm); with slope (50-50cm)	
Clearance zone (without edge)	(200 cm)	
Delimitation strip	contrast, width (5 ± 0.5 cm)	
Magnesia stand		
Magnesia stand for feet		
MAG2 Pommel Horse **MAG12 Landing mats 10cm**	**Stipulation**	**Result - Action**
Concordance with test report:		
Height of horse	115 cm ± 1cm, measured from floor	
Horizontal surface		
Levers and knob covered	Protection of anchor and floor support	
support below podium		
stability of pommels		
surface finishing of pommels		
Mats concordance with test report:		
Height of landing mats	10 cm ± 1 cm	
Dimension of mat surface	min. 400 cm x 400 cm	
Magnesia stand		
MAG3 Rings	**Stipulation**	**Result - Action**
Concordance with test report:		
Height of rings (inner side to floor)	290 cm ± 0.5 cm, measured from floor	
rings horizontal		
support below podium		
sufficiant weight at the ancors		
surface finishing of the rings		
fixation of rings to straps		
Dimension of mat surface	min. 200 cm x 500 cm	
Core and surface of mat	visual and tactile control of the landing area under the rings. Damages?	
Extra soft landing mat at the rings	400 cm * 200 cm	
Hard foam block (recommended)		
Ring hook		
Magnesia stand		

Apparatus Control MAG
(Final Control - Forms B)
(Forms A: see FIG Apparatus Norms Part III)

MAG4 Vaulting Table	Stipulation	Result - Action
Concordance with test report:		
Height (to the level of the run up area)	135 cm ± 1 cm	
Support below podium		
Fixation		
Stability		
Cushioning (legs, stand)		
Marking of the reference point		
run up area	length: 2500 (+10) cm	
	Board underneath 320 ± 1 cm	
	coloring / contrast to board	
Mat for hand (round-off entries)	Contrast, 3 x 120 x 100 cm (Tol: ±0,5; +10; ±1)	
Safety collar	Side min: 20cm	
	Front side: 20cm ± 0,5	
	length: 120 (+20) cm	
	No hindering of vaulting board's function	
	Contrast to springboard	
Landing zone	Landing mat min: 250 cm x 600 cm	
	Suppl. Mat: 200 cm x 600 cm (± 1cm)	
	Suppl. Mat attached to landing mat	
	5 cm Lines, 95 - 150 cm, center line	
Magnesia stand		
Magnesia stand for feet		
Additional soft crash mat	300 * 200 * 30 cm	
Additional supplementary mat	200 * 200 * 10 cm min	

MAG5 Parallel Bars	Stipulation	Result - Action
Concordance with test report:		
Height of bars	200 cm +/- 1 cm, measured from floor	
Bars horizontal		
surface finishing of the bars		
Support below podium		
Fixation		
Stability of attachment points		
Stability of the construction		
Surface horizontal, without gaps		
Dimension of mat surface	min. 1100 x 450 cm with specific shape	
Additional Supplementary mat	200 * 200 cm * 10 cm min	
Magnesia stand		

MAG6 Horizontal Bar	Stipulation	Result - Action
Concordance with test report:		
Height of the bar	280 cm +/- 1 cm, measured from floor	
+10cm height adjustment possible		
Bar horizontal		
surface finishing of the bars		
Fixation		
Support below podium		
sufficiant weight at the ancors		
Dimension of mat surface	min. 300 cm x 1200 cm	
Supplementary mats	2 x 400 cm x 200 cm	
Additional supplementary mat	200 * 200 cm * 10 cm min	
Magnesia stand		
Dedicated pad for prep of the bar		

Apparatus Control MAG
(Final Control - Forms B)
(Forms A: see FIG Apparatus Norms Part III)

MAG11 Landing Mats	**Stipulation**	**Result - Action**	
Concordance with test report:			
Height of landing mats	20 cm ± 1 cm		
Horizontal, even, without gaps			
Supplementary mats	No dislocation during performance expected		
MAG 14 Springboards	**Stipulation**	**Result - Action**	
Hard: Concordance with test rep.			
Soft: Concordance with test rep.			
Fixed springs			
Dot for hard boards			
Number of available boards	1 x H; 2 x S (eventually add spare: 1 x H; 1 x S)		
Colour	Contrast, no disturbing patterns		
Non slippery condition with board			

Signature _____ **Time & date** _____

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MAG
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Apparatus Control MAG
(Final Control - Forms B)
(Forms A: see FIG Apparatus Norms Part III)

APPARATUS CONTROL B (FC) - MEN'S ARTISTIC GYMNASTI(

Competition Logo

Competition: ***Name of the Competition***

Discipline: **MAG**	**Site:**	Date:
Final Control (FIG Apparatus Manager, TC Representatives, Delegate AC)		
MAG1 Floor	**Stipulation**	**Result - Action**
Surface area	width A (1200 ± 3 cm)	
	width B (1200 ± 3 cm)	
	diagonal (1697 ± 5 cm)	
horizontal, even, without gaps		
Border (Edge)	horizontal (100cm); with slope (50-50cm)	
Clearance zone (without edge)	(200 cm)	
Delimitation strip	contrast, ~~width (5 ± 0.5 cm)~~	
Magnesia stand	2 in FOP	***filled***
Magnesia stand for feet	4 in FOP	***filled***
Additional supplementary mat	200 * 200 * 10 cm min	**ONLY FOR Podium Training!**
MAG2 Pommel Horse **MAG12 Landing mats 10cm**	**Stipulation**	**Result - Action**
Height of horse	115 cm ± 1cm, measured from floor	
Horizontal surface		
Levers and knob covered	Protection of anchor and floor support	
stability of pommels		
surface finishing of pommels		
support below podium		
Height of landing mats	10 cm ± 1 cm	
Dimension of mat surface	min. 400 cm x 400 cm	
Magnesia stand		
MAG3 Rings	**Stipulation**	**Result - Action**
Height of rings (inner side to floor)	290 cm ± 0.5 cm, measured from floor	
rings horizontal		
support below podium		
surface finishing of the rings		
fixation of rings to straps		
Dimension of mat surface	min. 200 cm x 500 cm	
Core and surface of mat	visual and tactile control of the landing area under the rings. Damages?	
Extra soft landing mat at the rings	400 cm * 200 cm	
Hard foam block (recommended)		
Ring hook		
Magnesia stand		

Apparatus Control MAG
(Final Control - Forms B)
(Forms A: see FIG Apparatus Norms Part III)

MAG4 Vaulting Table	**Stipulation**	**Result - Action**
Height (to the level of the run up area)	135 cm ± 1 cm	
Fixation		
support below podium		
Stability		
Cushioning (legs, stand)		
Marking of the reference point		
run up area	length: 2500 (+10) cm	
	coloring / contrast to board	
Mat for hand (round-off entries)	Contrast, 3 x 120 x 100 cm	
Safety collar	Side min: 20cm	
	Front side: 20cm ± 0,5	
	length: 120 (+20) cm	
	Contrast to springboard	
Landing zone	Landing mat min: 250 cm x 600 cm	
	Suppl. Mat: 200 cm x 600 cm	
	Suppl. Mat attached to landing mat	
	5 cm Lines, 95 - 150 cm, center line	
Additional supplementary mat	200 * 200 * 10 cm min	**ONLY FOR Podium Training!**
Magnesia stand		
Magnesia stand for feet		
MAG5 Parallel Bars	**Stipulation**	**Result - Action**
Height of bars	200 cm +/- 1 cm, measured from floor	
Bars horizontal		
surface finishing of the bars		
support below podium		
Fixation		
Stability of attachment points		
Stability of the construction		
Mat surface horizontal, without gaps		
Dimension of mat surface	min. 1100 x 450 cm with specific shape	
Magnesia stand		
Additional supplementary mat	200 * 200 * 10 cm min	**ONLY FOR Podium Training!**

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Apparatus Control MAG
(Final Control - Forms B)
(Forms A: see FIG Apparatus Norms Part III)

MAG6 Horizontal Bar	**Stipulation**	**Result - Action**
Height of the bar	280 cm +/- 1 cm, measured from floor	
+10cm height adjustment possible		
Bar horizontal		
surface finishing of the bars		
Fixation		
Dimension of mat surface	min. 300 cm x 1200 cm	
Supplementary mats	2 x 400 cm x 200 cm	
Magnesia stand		
Dedicated pad for prep of the bar		
Additional supplementary mat	200 * 200 * 10 cm min	**ONLY FOR Podium Training!**
MAG11 Landing Mats	**Stipulation**	**Result - Action**
Height of landing mats	20 cm ± 1 cm	
Horizontal, even, without gaps		
Supplementary mats	No dislocation during performance expected	
MAG 14 Springboards	**Stipulation**	**Result - Action**
Fixed springs (*)		
Dot for hard boards		
Number of available boards	1 x H; 2 x S	
Boards (spare, below podium)	1 x H; 1 x S	
Non slippery condition with board underneath		

Signatures **Time & date**

Apparatus Control MAG
(Final Control - Forms B)

(Forms A: see FIG Apparatus Norms Part III)

Apparatus Control MAG
(Light Control - Forms B)
(Forms A: see FIG Apparatus Norms Part III)

APPARATUS CONTROL B (LC) - MAG GYMNASTICS

Competition Logo

Competition: ***Name of the Competition***

Discipline: **MAG**	Site:	Date:

Light Control (FIG Apparatus Manager)		
MAG1 Floor	**Stipulation**	**Result - Action**
elasticity		
diagonals 1697 ±5		
sides 1200 ±3		
MAG2 Pommel Horse **MAG12 Landing mats 10cm**	**Stipulation**	**Result - Action**
115 height , horizontal		
fixing points / safety cushioning		
fixation below the podium		
mats		
MAG3 Rings	**Stipulation**	**Result - Action**
fixing points safety		
fixation below podium		
290 height		
Core and surface of mat	visual and tactile control of the landing area under the rings. Damages?	
individual parts removed (adjustment devices, brushes etc.)		
MAG4 Vaulting Table	**Stipulation**	**Result - Action**
marking of Verticals		
135 Height, 25 m run up,		
soft and hard Board with fixed springs		
add Boards below podium		
marking of landing mat		
fixation below the podium		
fixation of run up		
MAG5 Parallel Bars	**Stipulation**	**Result - Action**
fixing points safety		
fixation below podium		
200 height, horizontal		
Board hard		
run up 4,75m (to end of the bars)		
End 2,75m (from end of the bars)		

Apparatus Control MAG
(Light Control - Forms B)
(Forms A: see FIG Apparatus Norms Part III)

MAG6 Horizontal Bar	**Stipulation**	**Result - Action**
fixing points safety		
fixation below podium		
280 height		
run up 6m		
height adjustment +10cm		
Dedicated pad for prep of the bar		
MAG11 Landing Mats	**Stipulation**	**Result - Action**
Horizontal, even, without gaps		
Supplementary mats	prescribed number ?	
MAG 14 Springboards	**Stipulation**	**Result - Action**
Fixed springs		
Number of available boards	2 x S; 1 x H	
Additional		**Result - Action**
Light		
Temperature		
Clearance zones		

Signature **Time & date**

IV
WAG 1
01.02.2001
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Standard Specification: Vaulting Table for Women Artistic Gymnastics

The standard specifications for vaulting tables for women artistic gymnastics are the same as for men artistic gymnastics, therefore, this standard refers to the FIG standard IV-MAG4.

See:

IV
MAG 4
01.02.2001
1-5

Standard Specification: Uneven Bars for Women Artistic Gymnastics

This standard is issued under the fixed designation FIG: IV-WAG2-15.03.2023; the numbers immediately following the designation indicate the date of original adoption by the FIG, or, in case of revision, the date of the last revision. This FIG standard was prepared by the Apparatus Commission of the FIG and participating FIG test laboratories. This standard was originally published in English only.

Introduction

The objective of this FIG standard is to provide equal opportunities for all athletes in FIG competitions by controlling the functional properties of uneven bars and to minimize any differences between competition and training equipment.

1 Scope

1.1 This specification covers the measurement of certain static stiffness properties, dynamic force - time and displacement - time relationships and the oscillation characteristics of uneven bars. This standard specification is applicable to all uneven bars that are to be used at any FIG-sanctioned event.

1.2 This specification does not imply that an injury cannot be incurred while using uneven bars which comply with this specification.

1.3 The test procedures associated with this standard may involve hazardous operations and equipment. This standard does not purport to address all the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to use.

2 Normative References

2.1 International Gymnastics Federation (FIG): Apparatus Rules: II-WAG2.

2.2 International Gymnastics Federation (FIG): Apparatus Rules: IV-MAG6.

3 Terminology

3.1 *Description of terms specific to this standard:*

3.1.1 *Cable tension*: The predetermined value of force (in N) exerted on the mounting cables of the completely-mounted unloaded uneven bars.

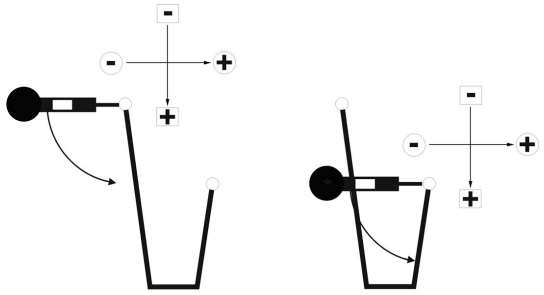
3.1.2 *Static tractive force*: The predetermined value of force (in N) exerted on the midpoint of a bar, pulling the bar vertically downwards.

3.1.3 *Starting position:* The position of an unloaded bar from which the total deflection in vertical and horizontal direction is determined. The midpoint of the bar shall serve as the point of reference for the measurements.

3.1.4 *Deflection:* The measured distance (in mm) between the starting position and the maximum displacement of the midpoint of a bar in vertical and horizontal direction respectively.

3.1.5 *Definition of spatial dimensions:* For the determination of the vertical and horizontal deflection of the midpoint of a bar the spatial dimensions are defined as illustrated in Figure 1.

Figure 1: Definition of Spatial Dimensions
(Pendulum in horizontal position before release)



Test upper bar **Test lower bar**

3.1.6 *Pendulum:* Tubular test body of given dimensions and mass with an additional low friction falling weight inside. The test body is attached to a bar with the help of two inflexible grasping arms, each of which is at the same distance from the midpoint of the bar, guaranteeing a low-friction rotation of the test body about the longitudinal axis of the bar.

3.1.7 *Maximum Force (F_{max}):* The maximum value of the reaction force in the direction of the pendulum's centre of gravity measured as the sum of the forces exerted on both grasping arms during the pendulum swing, expressed in Newtons.

3.1.8 *Hanging position:* Stable equilibrium position of the hanging pendulum under gravity conditions only.

3.1.9 *Horizontal position:* Position of the attached pendulum rectangular to the hanging position.

3.1.10 *Additional falling weight:* Cylindrical test body of given dimensions and mass inside the pendulum producing an additional impact stress on the gymnastic apparatus during pendulum swing.

3.1.11 *Internal drop height:* Predetermined sliding distance of the additional falling weight inside the pendulum.

3.1.12 *Initial tension:* Predetermined value of the force exerted on a bar, composed of the gravity of the attached pendulum and an additional tractive force pulling the bar-pendulum system vertically downwards.

3.1.13 *Frequency of oscillation:* Reciprocal of the value determined by the duration of the half amplitude interval divided by the number of oscillations of a bar-pendulum system within the half amplitude interval. The frequency is expressed in Hertz. See Figure 2 for illustration of the frequency determination.

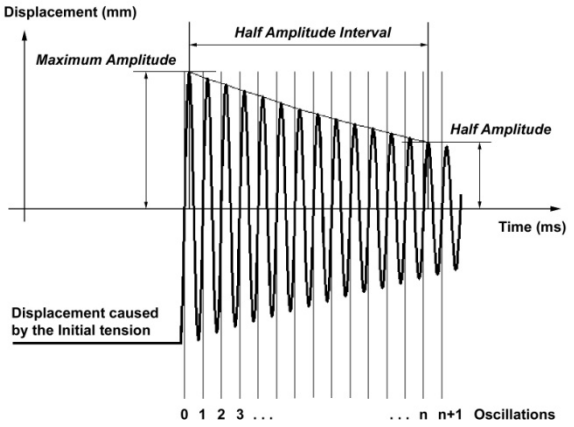
3.1.14 *Maximum amplitude:* Value of the amplitude (in mm) of the first oscillation of a bar-pendulum system after the release of the initial tension.

3.1.15 *Half amplitude:* Value of the amplitude

(in mm) of the first oscillation which is equal to or less than half the maximum amplitude.

3.1.16 *Half amplitude interval:* Duration of oscillation (in ms) between the passage of the maximum amplitude and the reaching of the half amplitude. See Figure 2 for illustration.

Figure 2: Oscillation Damping Parameters



4 Principle of Measurement

4.1 *The complete measurement is composed of three specific test procedures:*

4.1.1 *Test A - Static traction stress:* A bar of a mounted apparatus is pulled vertically downwards with a predetermined static tractive force. A measuring device mounted on the bar monitors the displacement - time history of the midpoint of the bar caused by this force. The maximum deflection is recorded with the aid of a data acquisition system. After the release of the static tractive force the bar must return into the starting position.

4.1.2 *Test B - Stress by pendulum swing:* A pendulum which is attached to a bar of a mounted apparatus is rotated from hanging position into horizontal position and then released. While it swings down, an additional falling weight inside the tubular pendulum slides down from a predetermined internal drop height until the weight strikes against the inside bottom of the pendulum, producing an additional impact stress on the gymnastic apparatus. A measuring device monitors the two-dimensional displacement - time history of the midpoint of the bar. Load cells inside both pendulum grasping arms monitor the reaction force - time history of the pendulum. Both are recorded with the aid of a data acquisition system. The test measures the maximum reaction force in the direction of the pendulum's centre of gravity as well as the positive deflection of the bar in vertical direction and the positive and negative deflection of the bar in horizontal direction.

4.1.3 *Test C - Oscillation damping:* A pendulum which is attached to a bar of a mounted apparatus is pulled vertically downwards until a predetermined initial tension is reached. The abrupt release causes a damped oscillation of the bar-pendulum system. A measuring device monitors the displacement - time history of the midpoint of the bar which is recorded with the aid of a data acquisition system. The test measures the frequency as well as the half amplitude interval of the oscillation.

4.2 Static and dynamic data obtained during these procedures are indicative of the static stiffness, elastic, damping, and oscillation properties of the uneven bars used in training and FIG-sanctioned competitions.

5 Performance Requirements

5.1 *Test A - Static traction stress:* When tested according to the procedures described in Section 9.2, the values of the measured variables shall be within the figures of Table 1.

Table 1: Figures for Test A – Static traction stress
x represents the measured variable

Test A: Static traction stress	
Upper bar	
Deflection (mm)	$70 \leq x \leq 100$
Lower bar	
Deflection (mm)	$70 \leq x \leq 100$

5.2 *Test B - Stress by pendulum swing:* When tested according to the procedures described in Section 9.3, the mean values of the measured variables shall be within the figures of Table 2.

Table 2: Figures for Test B – Stress by pendulum swing
x represents the mean value of the measured variable

Test B: Stress by pendulum swing	
Upper bar	
F_{max} (N)	$1500 \leq x \leq 1800$
Positive vertical deflection (mm)	$80 \leq x \leq 120$
Negative horizontal deflection (mm)	$-41 \leq x \leq -26$
Positive horizontal deflection (mm)	$46 \leq x \leq 71$
Lower bar	
F_{max} (N)	$1500 \leq x \leq 1800$
Positive vertical deflection (mm)	$80 \leq x \leq 120$
Negative horizontal deflection (mm)	$-41 \leq x \leq -26$
Positive horizontal deflection (mm)	$46 \leq x \leq 71$

5.3 *Test C - Oscillation damping:* When tested according to the procedures described in Section 9.4, the mean values of the measured variables shall be within the figures of Table 3.

Table 3: Figures for Test C – Oscillation damping
x represents the mean value of the measured variable

Test C: Oscillation damping	
Upper bar	
Frequency of oscillation (Hz)	$2.50 \leq x \leq 3.50$
Half amplitude interval (ms)	$350 \leq x \leq 5700$
Lower bar	
Frequency of oscillation (Hz)	$2.50 \leq x \leq 3.50$
Half amplitude interval (ms)	$350 \leq x \leq 5700$

6 Test Set-up and Apparatus

6.1 *Set-up for Test A - Static traction stress*: Any type of test set-up is acceptable that is capable to stress the test specimen under prescribed conditions and monitoring and recording the displacement - time history of the midpoint of the bar.

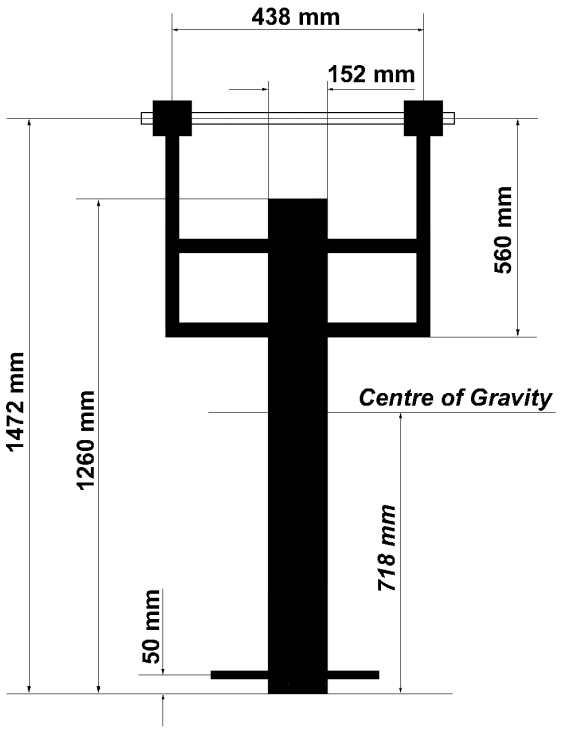
6.2 *Set-up for Test B - Stress by pendulum swing:* Any type of test set-up is acceptable that is capable of stressing the test specimen with a pendulum swing under prescribed conditions and monitoring and recording the displacement - time history of the midpoint of the bar and the reaction force - time history of the pendulum. It is optional, but desirable, that the pendulum is released from a magnet in the horizontal position.

6.3 *Set-up for Test C - Oscillation damping*: Any type of test set-up is acceptable that is capable of stressing a bar-pendulum system under prescribed conditions and monitoring and recording the displacement - time history of the midpoint of the bar. It is optional, but desirable, that the bar-pendulum system is released from a magnet at the prescribed initial tension.

6.4 *Pendulum* - The pendulum shall meet the following criteria:

6.4.1 *Mass and geometry:* The tubular test body shall have a mass of 40.0 kg ± 3% (including load cells, grasping arms and appliances for additional weights) and a geometry as specified in Figure 3. The load cells shall be located between the test body and the grasping arms. The weight of each grasping arm shall be 1.0 kg ± 3%.

Figure 3: Geometry of Tubular Test Body
(All dimensions with an accuracy of 3%)



6.4.2 *Pendulum fixation* - The pendulum fixation to a bar shall meet the following criteria:

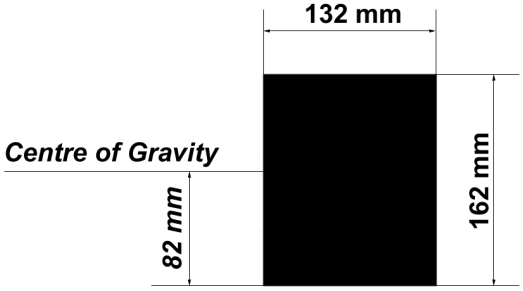
6.4.2.1 *Functional properties:* The fixation shall allow an immediate transfer of forces between pendulum and bar and guarantee a low-friction rotation of the pendulum about the longitudinal axis of the bar (the use of roll bearings is recommended).

6.4.2.2 *Friction of the bar-pendulum fixation* - The frictional properties of the fixation shall meet the criteria as specified in *FIG Apparatus Rules: IV-MAG6 Standard Specification for Horizontal Bars for Men Artistic Gymnastics*.

6.4.3 *Additional falling weight* - The additional falling weight shall meet the following criteria:

6.4.3.1 *Mass and geometry:* The cylindrical falling weight shall have a mass of 10.0 kg ± 0.1 kg and a geometry as specified in Figure 4.

Figure 4: Geometry of Additional Falling Load
(All dimensions with an accuracy of 3%)



6.4.3.2 *Friction within the tube of the test body* - The frictional properties of the additional falling weight shall meet the criteria as specified in *FIG Apparatus Rules: IV-MAG6 Standard Specification for Horizontal Bars for Men Artistic Gymnastics.*

6.4.3.3 *Damping of the additional falling weight at the inside bottom of the tubular test body* - The damping properties of the additional falling weight shall meet the criteria as specified in *FIG Apparatus Rules: IV-MAG6 Standard Specification for Horizontal Bars for Men Artistic Gymnastics.*

6.5 *Recording equipment* - The recording equipment shall meet the following criteria:

6.5.1 *Displacement - time:* The selection of the specific displacement - time recording equipment, including transducers and recorders, is at the discretion of the test laboratory. However, the transducers shall provide linear signals proportional to the two-dimensional displacement of the midpoint of a bar. If displacement is recorded, the test equipment shall have means to determine and record the starting position of the bar from which the total deflections are determined. The total system, detection and recording, shall be capable of measuring displacements of up to 200 mm at frequencies from 2 to 200 Hz to an accuracy of ± 1%. The minimum sampling rate of the data acquisition system shall be 500 Hz.

6.5.2 *Reaction force - time:* Any reaction force - time recording equipment, including load cells and recorders, which can monitor the reaction force exerted on the pendulum simultaneously with the displacement - time trace is acceptable. The total system, detection and recording, shall be capable of measuring reaction forces of up to 5000 N at frequencies from 2 to 200 Hz to an accuracy of ± 1%. The minimum sampling rate of the data acquisition system shall be 500 Hz.

7 Test Specimen

7.1 The test specimen submitted for testing shall consist of complete uneven bars as they are intended to be used during training and/or competition.

7.2 The test specimen shall comply with *FIG Apparatus Rules: II-WAG2*.

8 Conditioning and Test Temperature

8.1 The uneven parallel bars, mounted and assembled for use, shall be preconditioned at 50% ± 10% relative humidity and 21° C ± 3° C for a minimum of 24 hours prior to the test. All testing shall be carried out under the same conditions.

9 Laboratory Procedure (Test Method)

9.1 *General set-up:*

9.1.1 Mount the upper and lower bar to heights as prescribed for competitions (Part II). The inside width between the bars shall also be according to Part II.

9.1.2 The default cable tension shall be 2750 N ± 50 N provided that there is no other specific cable tension suggested by the manufacturer. If a specific cable tension is suggested by the manufacturer, then this suggested cable tension shall be used.

9.1.3 Install the displacement measuring device on the unloaded bars and determine the starting positions.

9.2 *Test A - Static traction stress:*

9.2.1 Pull the midpoints of the upper and lower bar individually vertically downwards with a static tractive force of 1350 N ± 20 N and capture, then record the resulting maximum deflections (mm) using recording equipment described in Section 6.5.

9.2.2 After the release of the static tractive force verify whether the bars return into the starting position.

9.3 *Test B - Stress by pendulum swing:*

9.3.1 Attach the pendulum (50 kg: 40 kg pendulum with additional 10 kg falling weight) to a bar in hanging position.

9.3.2 Move the pendulum from hanging position into horizontal position and move the additional falling weight inside the pendulum to the 50 cm ± 1 cm internal drop height position. For the direction of the pendulum swing at the upper and lower bar see Figure 1.

9.3.3 Release the pendulum and capture the two-dimensional displacement - time history of the midpoint of the bar and the reaction force - time history of the pendulum, using recording equipment described in Section 6.5.

9.3.4 Stress each bar by repeating the pendulum swing five times.

9.3.5 Immediately following each test, record the following measurements: F_{max} (N), positive vertical deflection (mm), as well as positive and negative horizontal deflection (mm).

9.3.6 All five tests per bar shall be used to determine the arithmetic mean values of the measured variables for each bar.

9.3.7 Repeat the measurements in 9.3.1 to 9.3.6 for the highest allowed changes in height of the stands according to Part II of the FIG Apparatus Norms.

9.4 *Test C - Oscillation damping:*

9.4.1 Attach the pendulum (50 kg: 40 kg pendulum with additional 10 kg falling weight at the inside bottom of the pendulum) to a bar in hanging position.

9.4.2 Pull down the pendulum vertically until the initial tension of 1000 N ± 30 N is reached.

9.4.3 Release the pendulum and capture the displacement - time history of the midpoint of the bar using recording equipment described in Section 6.5.

9.4.4 Repeat the above process for each bar five times.

9.4.5 Immediately following each test, record the following measurements: Frequency (Hz) and half amplitude interval (ms) of the oscillation.

9.4.6 All five tests per bar shall be used to determine the arithmetic mean values of the measured variables for each bar.

9.5 Calculate the values of all required variables rounded to the decimal places of the corresponding figures identified in Section 5.

10 Report

10.1 *The test report shall include the following information:*

10.1.1 Complete identification of the tested uneven bars, including type, source, manufacturer's model number (if appropriate), dimensions of test specimen, and any other pertinent information. Photographs may be included in the test report for sample documentation purposes.

10.1.2 Test identification number according to the internal regulations between the FIG Test Institutes.

10.1.3 Complete identification of the testing laboratory including test technician and test laboratory manager (if appropriate).

10.1.4 Conditions of test, including test date, temperature and humidity.

10.1.5 Test height and cable tension of the unloaded horizontal bar.

10.1.6 *Test A - Static traction stress:* Description of the Static tractive force.

10.1.7 *Test B - Stress by pendulum swing:* Description of the pendulum mass, the additional falling weight and the internal drop height.

10.1.8 *Test C - Oscillation damping:* Description of the pendulum mass (including the additional falling weight at the inside bottom of the pendulum) and the initial tension.

10.1.9 Description of the test results relative to the performance requirements identified in Section 5.

Standard Specification: Balance Beams for Women Artistic Gymnastics

This standard is issued under the fixed designation FIG: IV-WAG3-01.12.1994; the numbers immediately following the designation indicate the date of original adoption by the FIG or, in case of revision, the date of the last revision. This FIG standard was prepared by the Apparatus Commission of the FIG and participating FIG test laboratories. This standard was originally published in English only.

Introduction

The objective of this FIG standard is to provide equal opportunities for all athletes in FIG competitions by controlling the functional properties of balance beams and to minimize any differences between competition and training equipment.

1 Scope

1.1 This specification covers the measurement ofcertain elastic and shock absorbing characteristics, as well as frictional characteristics of balance beams. This standard specification is applicable to all balance beams that are to be used at any FIG-sanctioned event.

1.2 This specification does not imply that an injury cannot be incurred while using a balance beam which complies with this specification.

1.3 The test procedures associated with this standard may involve hazardous operations and equipment. This standard does not purport to address all the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to use.

2 Normative References

2.1 Society of Automotive Engineers: SAE J211 Recommended Practice for Instrumentation for Impact Tests – Requirements for Channel Class 1000, October 1988.

2.2 International Gymnastics Federation (FIG): Apparatus Rules: II-WAG3.

3 Terminology

3.1 *Description of terms specific to this standard:*

3.1.1 *Base plane:* The starting reference plane of the balance beam from which deflection is determined. It is taken as the upper surface of the balance beam loaded by the loading disk prior to any impact.

3.1.2 *Deflection (D):* The measured distance (in mm) between the base plane and the bottom surface of the loading disk during the impact.

3.1.3 *Maximum deflection (D_{max}):* The maximum value of deflection (in mm) measured during the impact.

3.1.4 *Force (F):* The force applied to the balance beam during the impact, expressed in Newtons.

3.1.5 *Energy of deflection (E):* The integration value or calculated area under the force-deflection curve expressed in Nm (Newton*meter). The domain of integration is from the rising point to the maximum point of deflection on the curve.

3.1.6 *Rebound deflection (D_r):* The maximum rebounding displacement (in mm) of the bottom surface of the loading disk, measured from the plane of maximum deflection.

3.1.7 *Rebound time:* The difference in time (in s) between the point of maximum deflection and the point of rebound deflection.

3.1.8 *Rebound velocity (V_r):* The quotient of rebound deflection and rebound time expressed in mm/s.

3.1.9 *Intensity of rebound (D_rV_r):* The product of rebound deflection and rebound velocity expressed in mm^2/s.

3.1.10 *Loading disk:* The part of the test apparatus which applies the specified load to the test specimen.

3.1.11 *Slider:* A test body of given mass and geometry for measuring frictional characteristics of the balance beam. The slider includes a test sole which is bonded to the bottom of the slider and is made of synthetic material with defined friction properties.

3.1.12 *Maximum traction force:* The maximum statical friction force expressed in Newtons, observed at the beginning of the pulling movement of the slider.

3.1.13 *Friction coefficient of balance beam:* Quotient of the maximum traction force (in N) and the weight of the slider (in N).

4 Principle of Measurement

4.1 *The complete measurement procedure consists of two specific test procedures:*

4.1.1 *Test A - Elasticity and shock absorption:* A specimen balance beam is impacted by dropping an impactor from a predetermined height onto a set of rubber springs and a loading disk which are located on the top surface of the test specimen prior to the impact. Transducers mounted in the loading disk shall monitor the force – time history and displacement – time history of the loading disk. This data shall be recorded with the aid of a data acquisition system.

4.1.2 *Test B - Top friction:* A slider is pulled horizontally upon the surface of a specimen balance beam at a defined loading rate. A transducer connected to the pulling string shall monitor the maximum traction force generated during the pulling movement.

4.2 Data obtained during these procedures are indicative of the elastic and shock absorbing properties and the top friction characteristics of balance beams used in training and FIG-sanctioned competitions.

FIG International Gymnastics Federation
Standard Specification for Balance Beams
WAG – Women Artistic Gymnastics

5 Performance Requirements

5.1 *Test A – Elasticity and Shock absorption:* When tested according to the procedures described in Section 9.1, the values of the measured variables shall be within the figures of Table 1.

5.2 *Test B – Top friction:* When tested according to the procedures described in Section 9.2, the mean values of the measured variables shall be within the figures of Table 2.

6 Test Apparatus

Table 1: Figures for Test A – Elasticity and shock absorption of balance beams
See Figure 2 for an illustration of the impact sites.
x represents the mean values of the measured variables

Test A : Elasticity and shock absorption of balance beam				
	D_{max} (mm)	E (Nm)	D_r (mm)	D_rV_r (mm²/s)
Mean value across impact sites 1 to 7	3.5 ≤ x ≤14.0	2.5 ≤ x ≤ 9.5	3.0 ≤ x ≤ 20.0	300 ≤ x ≤ 4800
Difference between highest and lowest mean value on impact sites 1 to 7	≤ 5.0	≤ 3.0	≤ 5.0	≤ 2400

6.1 *Test A – Elasticity and Shock absorption of balance beam:*

6.1.1 *Impact test machine:* Any type of dynamic testing apparatus that is capable of impacting a test specimen using the prescribed loading condition and monitoring and recording the force - time history and deflection - time history of the loading disk is acceptable. The impact test machine shall have sufficient rigidity to eliminate undesirable vibrations in the apparatus which might be recorded on the force - time curve and deflection - time curve. The impact test machine shall also be designed in such a manner that only the bottom surface of the loading disk contacts the test specimen at any time during the test procedures.

6.1.2 *Loading system - The loading system of the impact test machine shall meet the following requirements (see Figure 1).*

Figure 1: Setup of the loading system

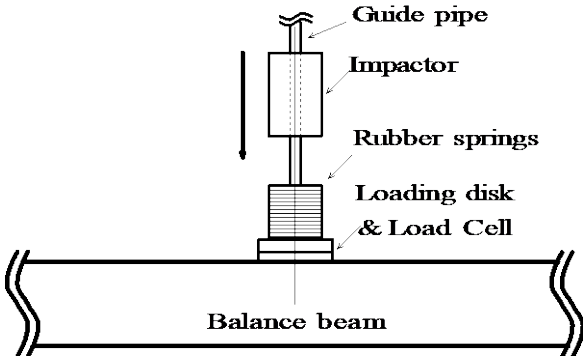


Table 2: Figures for Test B – Top friction of balance beam
See Figure 3 for an illustration of the test sites.
x represents the mean value of the measured variable

Test B : Top friction of balance beam	
	Friction coefficient of balance beam
Mean value across test sites	0.35 ≤ x ≤ 0.60
Difference between highest and lowest mean value on test	≤ 0.05
Difference between mean values of orthogonal test directions	≤ 0.05

6.1.2.1 *Characteristics of the dynamic load:* The maximum dynamic force shall be 1300 N ± 2 % when this loading system is applied to the testing anvil. The time from the onset of force application to the time of maximum force shall be 50 ms ± 2 ms.

6.1.2.2 *Impactor:* The dropping impactor shall be 15 kg ± 0.1 kg and shall have a flat impact face. The impactor shall have the shape of a thick cylinder and shall be dropped along a guide pipe. The decision of the size of outside and inside diameters of the impactor is at the discretion of the test laboratory, but the clearance between the inside hole of the impactor and the guide pipe shall be 2 mm ± 0.2 mm. The dropping height of the impactor shall be 120 mm ± 1 mm to the upper surface of the rubber springs.

6.1.2.3 *Release mechanism:* The release mechanism shall be unattached to the loading disk and the guide pipe to prevent an additional load with the attached impactor on the loading disc and the test specimen before the impact.

6.1.2.4 *Loading disk and guide pipe:* The loading disk shall have a diameter of 70 mm ± 0.5 mm. The total mass of the loading disk including the force transducer and the guide pipe shall be 5 kg ± 0.2 kg.

6.1.2.5 *Rubber springs:* A set of rubber springs shall be selected so as to meet the requirements described in 6.1.2.1.

6.1.3 *Recording equipment - The recording equipment shall meet the following criteria:*

6.1.3.1 *Force - time:* The selection of the specific force - time recording equipment, including transducers and recorders, is at the discretion of the test laboratory. However, the recording system shall have a frequency response adequate to measure the peak force value to an accuracy of ± 3% of the true value. The total system, detection and recording, shall be capable of measuring impact forces of up to 2000 N at frequencies from 2 to 1000 Hz to an accuracy of ± 3%. The minimum sampling rate of the data acquisition system shall be 5000 Hz.

6.1.3.2 *Displacement - time:* The selection of the specific displacement - time recording equipment, including transducers and recorders, is at the discretion of the test laboratory. However, the recording system shall have a frequency response adequate to measure the dynamic displacement value to an accuracy of ± 3% of the true value. The total system, detection and recording, shall be capable of measuring the displacement of ± 50 mm at frequencies from 2 to 1000 Hz to an accuracy of ± 3%. The minimum sampling rate of the data acquisition system shall be 5000 Hz.

6.1.3.3 *Filtering:* The signal from all transducers shall be conditioned with a low pass filter which complies with Channel Class 1000 of SAE Recommended Practice J211. A fourth-order Butterworth low pass filter with a cut-off frequency of 1000 Hz meets this requirement.

6.2 *Test B - Top friction of the balance beam:*

6.2.1 *Measurement device:* Any type of friction testing apparatus that is capable of pulling a slider on the surface of a specimen balance beam at a required test velocity is acceptable. During the test, the traction force – time history of the slider shall be monitored and recorded.

6.2.2 *Slider:* The slider shall have a mass of 5 kg ± 0.2 kg. A square-shaped test sole with a thickness of 10mm ± 0.5 mm and a size of 40 mm ± 1 mm shall be bonded to the bottom of the slider. The thickness of the test sole shall be decreased to 75% ± 5% of the original thickness at a pressure of 5 N/cm^2. The coefficient of static friction of the test sole shall be 0.25 ± 0.03.

6.2.3 The slider shall be pulled at a constant loading rate of 5 N/s ± 0.5 N/s.

6.2.4 Recording equipment - The recording equipment shall meet the following criteria:

6.2.4.1 *Force - time:* The selection of the specific force - time recording equipment, including transducer and recorder, is at the discretion of the test laboratory. The total system, detection and recording, shall be capable of measuring traction forces up to 100 N at frequencies from 2 to 100 Hz to an accuracy of ± 3%. The minimum sampling rate of the data acquisition system shall be 200 Hz.

7 Test Specimen

7.1 The test specimen submitted for testing shall consist of a complete balance beam as it is intended to be used during training and/or competition.

7.2 The test specimen shall comply with FIG Apparatus Rules: II-WAG3.

8 Conditioning and Test Temperature

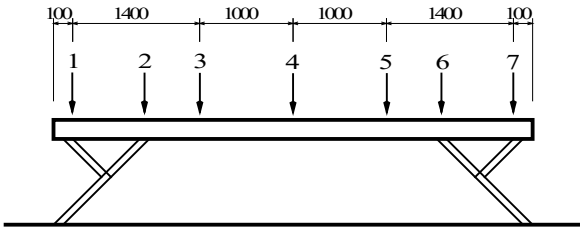
8.1 The test specimen shall be preconditioned at 50% ± 10% relative humidity and 21° C ± 3° C for a minimum of 24 hours prior to the test. All testing shall be carried out under the same conditions.

9 Laboratory Procedure (Test Method)

9.1 *Test A – Elasticity and Shock absorption of the balance beam:*

9.1.1 *Impact sites:* A total of seven impact sites shall be designated on the test specimen. See Figure 2 for an illustration of the impact sites.

Figure 2: Impact sites on the balance beam (distances in mm)



2, 6 : intersections of beam and legs

9.1.2 *Impact test procedures:*

9.1.2.1 Place the test specimen under the impact test machine on a smooth, solid and horizontal floor (concrete or metal plate) and orient the loading disk such that the centre of the loading disk contacts one of the designated impact test sites.

9.1.2.2 Raise the impactor to an appropriate drop height such that it will impact on the rubber springs and generate the proper dynamic load described in Section 6.1.2.

9.1.2.3 Release the impactor and capture the force - time history and displacement - time history using the recording equipment described in Section 6.1.3.

9.1.2.4 Upon completion of a given impact test, raise the impactor off the loading disk.

9.1.2.5 The duration between tests at a given impact site shall not be less than 120 seconds.

9.1.2.6 Impact each of the seven impact sites five times. Each test specimen shall receive a total of 35 impacts.

9.1.3 *Calculations:*

9.1.3.1 Immediately following each test, record the following measurements: D_{max} (mm), E (Nm), D_r (mm) and D_rV_r (mm^2/s).

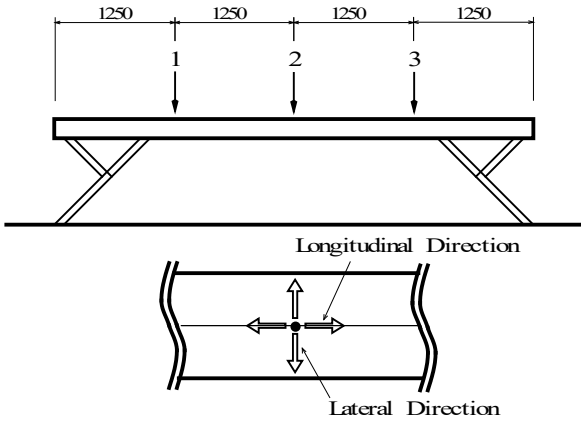
9.1.3.2 Determine the arithmetic mean values of the

measured variables for each impact site and for the overall mean values of the measured variables across all impact sites. Determine also the differences between the highest and lowest mean values of the measured variables for each test site and across all test sites.

9.2 Test B – Top friction of the balance beam:

9.2.1 *Test sites and directions:* A total of three test sites shall be designated on the test specimen as illustrated in Figure 3. Four orthogonal test directions for the traction of the slider shall be also designated on each test site as illustrated in Figure 3.

Figure 3: Top friction test sites and directions on the balance beam (distances in mm)



9.2.2 *Friction test procedures:*

9.2.2.1 Place the complete test specimen on a smooth, solid and horizontal floor.

9.2.2.2 Place the slider on the test specimen in such a manner that the centre of its sole will contact one of the designated test sites, and also in such a manner that the pulling direction of the slider will conform to one of the designated test directions. Just before putting the slider on the test specimen, magnesium carbonate powder of 1g shall be spread on the surface of the test site each time.

9.2.2.3 Pull the slider horizontally at a constant loading rate of 5 N/s ± 0.5 N/s and record the traction force – time history using recording equipment described in Section 6.2.4.

9.2.2.4 Repeat the procedure given in 9.2.2.2 and 9.2.2.3 five times at each test site and in each test direction.

9.2.2.5 Each test specimen shall receive a total of 60 friction test procedures.

9.2.3 *Calculations:*

9.2.3.1 Immediately following each test, record the friction coefficient.

9.2.3.2 Determine the overall mean value of the friction coefficient across the test sites 1 to 3. Also determine the difference between the highest and the lowest mean value of the friction coefficient between all test sites, and the difference between the mean values of the friction coefficients of the orthogonal test directions between all test sites.

9.3 Calculate the values of all required variables rounded to the decimal places of the corresponding figures identified in Section 5.

10 Report

10.1 *The test report shall include the following information:*

10.1.1 Complete identification of the tested balance beam, including type, source, manufacturer's model number (if appropriate), dimensions of test specimen, and any other pertinent information. Photographs may be included in the test report for sample documentation purposes.

10.1.2 Test identification number according to the internal regulations between the FIG Test Institutes.

10.1.3 Complete identification of the testing laboratory including test technician and test laboratory manager (if appropriate).

10.1.4 Conditions of test, including test date, temperature and humidity.

10.1.5 Identification of performed parts of the test – Test A and Test B.

10.1.6 Description of the impactor mass and the drop height conditions (Test A), mass and loading rate of the slider (Test B). A sample loading rate curve may be included in the test report to indicate compliance with the loading requirements of 6.1.2.1.

10.1.7 Description of all test results related to the performance requirements identified in Section 5.

10.1.8 *Supplemental description of the test results:*

10.1.8.1 Maximum value, minimum value and standard deviation of D_{max}, E, D_r and D_rV_r variables according to Test A.

10.1.8.2 Mean values of D_{max}, E, D_r and D_rV_r variables at each impact site according to Test A.

10.1.8.3 D_{max}, E, D_r and D_rV_r values for all tests according to Test A.

10.1.8.4 Mean values and standard deviations of the friction coefficients at each test site and in each direction according to Test B.

10.1.8.5 Friction coefficient values for all tests according to Test B.

Standard Specification: Floors for Women Artistic Gymnastics

This standard is issued under the fixed designation FIG: IV-WAG4-01.01.2016; the numbers immediately following the designation indicate the date of original adoption by the FIG or, in case of revision, the date of the last revision. This FIG standard was prepared by the Apparatus Commission of the FIG and participating FIG test laboratories. This standard was originally published in English only.

The standard specifications for floors for women artistic gymnastics are the same as for men artistic gymnastics, therefore, this standard refers to the FIG standard IV-MAG1.

See:

IV
MAG 1
01.01.2016
1-4

This standard is subject to revision at any time by the FIG Apparatus Commission. You are invited to comment on revision of this standard or on additional standards. Comments should be addressed to the FIG General Secretary.

IV
WAG 11
01.08.1996
1

Standard Specification: 20 cm Landing Mats for Women Artistic Gymnastics

This standard is issued under the fixed designation FIG: IV-WAG11-01.08.1996; the numbers immediately following the designation indicate the date of original adoption by the FIG or, in case of revision, the date of the last revision. This FIG standard was prepared by the Apparatus Commission of the FIG and participating FIG test laboratories. This standard was originally published in English only.

The standard specifications for 20 cm landing mats for women artistic gymnastics are the same as for men artistic gymnastics, therefore, this standard refers to the FIG standard IV-MAG11.

See:

IV
MAG 11
01.08.1996
1-3

This standard is subject to revision at any time by the FIG Apparatus Commission. You are invited to comment on revision of this standard or on additional standards. Comments should be addressed to the FIG General Secretary.

Standard Specification: Vaulting Boards for Women Artistic Gymnastics

This standard is issued under the fixed designation FIG: IV-WAG14-01.01.2006; the numbers immediately following the designation indicate the date of original adoption by the FIG or, in case of revision, the date of the last revision. This FIG standard was prepared by the Apparatus Commission of the FIG and participating FIG test laboratories. This standard was originally published in English only.

The standard specifications for vaulting boards for women artistic gymnastics are the same as for men artistic gymnastics, therefore, this standard refers to the FIG standard IV-MAG14.

See:

IV
MAG 14
01.01.2015
1-3

This standard is subject to revision at any time by the FIG Apparatus Commission. You are invited to comment on revision of this standard or on additional standards. Comments should be addressed to the FIG General Secretary.

Apparatus Control WAG
(Forms B)
(Forms A: see FIG Apparatus Norms Part III)

Prior to every FIG Event in MAG, WAG, TRA and RG an apparatus control shall be scheduled before the first contact of athletes with the equipment. The completed forms have to be reported to the TC President or if she is not at the competitions site to the FIG Event Delegate and to the President of the FIG Apparatus Commission. According to the FIG event, different forms shall be used:

Form A: (FIG TC Delegate)
Competitions: World Cups, Continental Games (without FIG Apparatus Commissioner)

Main aspects for the apparatus control with form A:

- To be performed 1-2 h prior to the first contact of the athletes with the equipment.
- To be done for training hall (every set), warming up hall and competition hall.
- Control of specifications of the FIG Apparatus Manual.
- Judgment of non-described safety relevant aspects.
- Control of all adjustable heights, lengths etc. at the apparatuses.
- Control of all security relevant parts (fixings, stability and mats displacement).
- If necessary, monitoring of apparatus relevant ad hoc decisions of the TP / TC or other FIG Authorities.

Remark: Forms A are published in FIG Apparatus Norms Part III.

Form(s) B: (FIG Apparatus Commissioner)
Competitions: World Championships and Olympic Games (with FIG Apparatus Commissioner)

Main aspects for the apparatus control with forms B:

(IC) Intensive Control (FIG Apparatus Commissioner):
- To be done for training hall (every set), warming up hall and competition hall
- To be performed prior to the first contact of the athletes with the equipment
- Control of accordance of equipment with the tested Specimen
- Control of all specifications of the FIG Apparatus Manual
- Judgment of non-described safety relevant aspects
- Report of the results to the Technical President
- If necessary monitoring of apparatus relevant ad hoc decisions of the TP / TC or other FIG Authorities

(FC) Final Control (Technical Committee Member(s), FIG Apparatus Commissioner):
- To be performed immediately prior to the competition or the podium training.
- Control of all adjustable heights, lengths etc. at the apparatuses.
- Control of all security relevant parts (fixings, stability and mats displacement).

(LC) Daily Light Control (FIG Apparatus Commissioner):
- To be performed every day in all training and warming up halls.
- Control of accordance of the equipment with the time of the extensive control.
- Control of all adjustable heights, lengths etc. at the apparatuses.
- Control of all security relevant parts (fixings, stability and mats displacement).

Apparatus Control WAG
(Forms B)

(Forms A: see FIG Apparatus Norms Part III)

Apparatus Control WAG
(Intensive Control - Forms B)
(Forms A: see FIG Apparatus Norms Part III)

APPARATUS CONTROL B (IC) - WOMEN'S ARTISTIC GYMNASTICS

Competition Logo

Competition: ***Name of the Competition***

Discipline: **WAG** Site: Date:

General intensive Control (FIG Apparatus Manager)			
WAG1 Vaulting Table	**Stipulation**	**Result - Action**	
Concordance with test report:			
Height (to the level of the run up area)	125 cm ± 1 cm		
Support below podium			
Fixation			
Stability			
Cushioning (legs, stand)			
Marking of the reference point			
run up area	length: 2500 (+10) cm		
	Board underneath 320 ± 1 cm		
	coloring / contrast to board		
Mat for hand (round-off entries)	Contrast, 3 x 120 x 100 cm (Tol: ±0,5; +10; ±1)		
Safety collar (*)	Side min: 20cm		
	Front side: 20cm ± 0,5		
	length: 120 (+20) cm		
	No hindering of vaulting board's function		
	Contrast to springboard		
Landing zone	Landing mat min: 250 cm x 600 cm		
	Suppl. Mat: 200 cm x 600 cm (± 1cm)		
	Suppl. Mat attached to landing mat		
	5 cm Lines, 95 - 150 cm, center line		
Magnesia stand			
Magnesia stand for feet			
Additional soft crash mat	300 * 200 * 30 cm		
Additional supplementary mat	200 * 200 * 10 cm min		
WAG 14 Springboards	**Stipulation**	**Result - Action**	
Hard: Concordance with test rep.			
Soft: Concordance with test rep.			
Fixed springs			
Dot for hard board			
Number of available boards	3 x S; 1 x H (eventual add spare: 1 x H; 1 x S)		
Colour	Contrast, no disturbing patterns		
Non slippery condition with board underneath			
WAG2 Uneven P. Bar	**Stipulation**	**Result - Action**	
Concordance with test report:	***0***		
Distance of the bars	181 cm +/- 1 cm, (marked by Commissioner)		
Height of the upper bar	255 cm +/- 1 cm, measured from floor		
Height of the lower bar	175 cm +/- 1 cm, measured from floor		
Bars horizontal			
surface finishing of the bars			
Fixation			
Support below podium			
sufficiant weight at the ancors			
Height adjustement (+5cm)	at the uprights		
Dimension of mat surface	min. 200 cm x 1400 cm		
Position of the mat to the lower bar	614,6 cm minimum (equ. 700 cm to the middle)		
Supplementary mat	200 cm x 400 cm		
Hard foam block	50 * 50 * 50 cm		
Magnesia stand			
Magnesia stand for feet	only on podium		
Additional supplementary mat	200 * 200 * 10 cm		
Additional spotter mat	15 * 170 * 120 cm		

Apparatus Control WAG
(Intensive Control - Forms B)
(Forms A: see FIG Apparatus Norms Part III)

WAG3 Balance Beam	**Stipulation**	**Result - Action**	
Concordance with test report:	***0***		
Height of the surface	125 cm +/- 1 cm, measured from floor		
Surface horizontal			
Cushioning (legs, stand)			
Support below podium	not needed (no podium)		
Stability (tilting prevention)	Fixation, with movement allowed parallel to beam		
Stability of attachment points			
Stability of the construction			
Dimension of mat surface	min. 1800 x 400 cm with specific shape / 8 m mounting side		
Contrast to beams surface			
Surface horizontal, without gaps			
Supplementary mat	200 cm x 400 cm		
Magnesia stand		***filled***	
Magnesia stand for feet		***filled***	
Multifunctional carpette mat for use on the beam (only for TR/WU)			
Additional supplementary mat	200 * 200 * 10 cm min		
WAG4 Floor	**Stipulation**	**Result - Action**	
Concordance with test report:	***0***		
Surface area	width A (1200 ± 3 cm)		
	width B (1200 ± 3 cm)		
	diagonal (1697 ± 5 cm)		
horizontal, even, without gaps			
Border (Edge)	100 cm: horizontal (50cm); slope (50cm); horiz. (0cm)		
Clearance zone (without edge)	(200 cm)		
Delimitation	contrast, width (5 ± 0.5 cm)		
supplementary mat	200 * 200 * 10 cm		
Magnesia stand	1 in TR/WU; 2 in FOP		
Magnesia stand for feet	2 in TR/WU; 4 in FOP		
WAG11 Landing Mats	**Stipulation**	**Result - Action**	
Concordance with test report:	***0***		
Height of landing mats	20 cm ± 1 cm		
Horizontal, even, without gaps			
Supplementary mats	No dislocation during performance expected		

Apparatus Control WAG
(Intensive Control - Forms B)

(Forms A: see FIG Apparatus Norms Part III)

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Apparatus Control WAG
(Final Control - Forms B)
(Forms A: see FIG Apparatus Norms Part III)

APPARATUS CONTROL B (FC) - WOMENS' ARTISTIC GYMNASTICS

Competition Logo

Competition: ***Name of the Competition***

Discipline: **WAG**	**Final Control: Field of Play**	Date:

Final Control (FIG Apparatus Manager, TC Representatives, Delegate AC)		
WAG1 Vaulting Table	**Stipulation**	**Result - Action**
Height (to the level of the run up area)	125 cm ± 1 cm	
Fixation		
Stability		
Cushioning (legs, stand)		
Marking of the reference point		
run up area	length: 2500 (+10) cm	
	coloring / contrast to board	
Mat for hand (round-off entries)	Contrast, 3 x 120 x 100 cm	
Safety collar	Side min: 20cm	
	Front side: 20cm ± 0,5	
	length: 120 (+20) cm	
	Contrast to springboard	
Landing zone	Landing mat min: 250 cm x 600 cm	
	Suppl. Mat: 200 cm x 600 cm	
	Suppl. Mat attached to landing mat	
	5 cm Lines, 95 - 150 cm, center line	
Magnesia stand		
Magnesia stand for feet		
Additional supplementary mat	200 * 200 * 10 cm min	**only for Podium Training!**
WAG 14 Springboards	**Stipulation**	**Result - Action**
Fixed springs		
Dot for hard board		
Number of available boards	3 x S; 1 x H	
Boards (spare, below podium)	1 x H; 1 x S	
Non slippery condition with board underneath		
WAG2 Uneven P. Bar	**Stipulation**	**Result - Action**
Distance of the bars	181 cm +/- 1 cm, (marked by Commissioner)	
Height of the upper bar	255 cm +/- 1 cm, measured from floor	
Height of the lower bar	175 cm +/- 1 cm, measured from floor	
Bars horizontal		
surface finishing of the bars		
Fixation		
Dimension of mat surface	min. 200 cm x 1400 cm	
Position of the mat to the lower bar	614,6 cm min. (equ. 700 cm to the middle)	
Hard foam block	50 * 50 * 50 cm	
Supplementary mat	200 cm x 400 cm	
Magnesia stand		
Magnesia stand for feet		
Additional supplementary mat	200 * 200 * 10 cm min	**only for Podium Training!**
Additional supplementary mat	15 * 170 * 120 cm	**only for Podium Training!**

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Apparatus Control WAG
(Final Control - Forms B)
(Forms A: see FIG Apparatus Norms Part III)

WAG3 Balance Beam	**Stipulation**	**Result - Action**
Height of the surface	125 cm +/- 1 cm, measured from floor	
Surface horizontal		
Cushioning (legs, stand)		
Stability (tilting prevention)	Fixation if necessary	
Dimension of mat surface	min. 1800 x 400 cm with specific shape	
Contrast to beams surface		
Surface horizontal, without gaps		
Supplementary mat	200 cm x 400 cm	
Magnesia stand		
Magnesia stand for feet		
Additional supplementary mat	200 * 200 * 10 cm min	**only for Podium Training!**
WAG4 Floor	**Stipulation**	**Result - Action**
Surface area	width A (1200 ± 3 cm)	
	width B (1200 ± 3 cm)	
	diagonal (1697 ± 5 cm)	
horizontal, even, without gaps		
Edge	horizontal (100cm); with slope (50-50cm)	
Clearance zone (without edge)	(200 cm)	
Delimitation strip	contrast, width (5 ± 0.5 cm)	
Magnesia stand for feet		
Magnesia stand for feet	4 in FOP	
Additional supplementary mat	200 * 200 * 10 cm min	**only for Podium Training!**
WAG11 Landing Mats	**Stipulation**	**Result - Action**
Height of landing mats	20 cm ± 1 cm	
Horizontal, even, without gaps		
Supplementary mats	No dislocation during performance expected	

Signatures **Time & date**

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Apparatus Control WAG
(Final Control - Forms B)

(Forms A: see FIG Apparatus Norms Part III)

Apparatus Control WAG
(Light Control - Forms B)
(Forms A: see FIG Apparatus Norms Part III)

APPARATUS CONTROL B (LC) - WOMEN'S ARTISTIC GYMNASTICS

Competition: ***0***

Discipline: **WAG** Site: Date: 1900-01-00

Light Control (FIG Apparatus Commissioner)

WAG1 Vaulting Table	**Stipulation**	**Result - Action**
marking of Verticals		
135 Height, 25 m run up,		
soft and hard Board with fixed springs		
add Boards below podium		
marking of landing mat		
fixation below the podium		
fixation of run up		
Additional supplementary mat	200 * 200 * 10 cm min	
WAG2 Uneven Bar(s)	**Stipulation**	**Result - Action**
Distance of the bars	181 cm +/- 1 cm, (marked by Commissioner)	
Height of the upper bar	255 cm +/- 1 cm, measured from floor	
Height of the lower bar	175 cm +/- 1 cm, measured from floor	
Bars horizontal		
surface finishing of the bars		
Fixation		
fixing points safety		
fixation below podium		
Position of the mat to the lower bar	614,6 cm min. (equ. 700 cm to the middle)	
Hard foam block	50 * 50 * 50 cm	
Supplementary mat	200 cm x 400 cm	
Additional supplementary mat	200 * 200 * 10 cm min	
Additional supplementary mat	15 * 170 * 120 cm	
WAG3 Balance Beam(s)	**Stipulation**	**Result - Action**
Cushioning (legs, stand)		
Stability of attachment points		
Stability of the construction		
Surface horizontal, without gaps		
Multifunctional carpette mat for use on the beam (only for TR and WU)		
Additional supplementary mat	200 * 200 * 10 cm min	
WAG4 Floor	**Stipulation**	**Result - Action**
elasticity		
diagonals 1697 ±5		
sides 1200 ±3		
Additional supplementary mat	200 * 200 * 10 cm min	
WAG11 Landing Mats	**Stipulation**	**Result - Action**
Horizontal, even, without gaps		
Supplementary mats		
WAG 14 Springboards	**Stipulation**	**Result - Action**
Fixed springs		
Number of available boards	_ x S; 1 x H	
Additional		**Result - Action**
Light		
Temperature		
Clearance zones		

Signature **Time & date**

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01.08.2022
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Apparatus Control WAG
(Light Control - Forms B)

(Forms A: see FIG Apparatus Norms Part III)

Standard Specification: Rhythmic Gymnastic Floors

This standard is issued under the fixed designation FIG: IV-RG1-01.06.2018; the numbers immediately following the designation indicate the date of original adoption by the FIG, or, in case of revision, the date of the last revision. This FIG standard was prepared by the Apparatus Commission of the FIG and participating FIG test laboratories. This standard was originally published in English only.

Introduction

The objective of this FIG standard is to provide equal opportunities for all athletes in FIG competitions by controlling the functional properties of rhythmic gymnastic floors and to minimize any differences between competition and training equipment.

1 Scope

1.1 This specification covers the measurement of certain shock-absorbing, static stiffness and top friction characteristics of rhythmic gymnastic floors. This standard specification is applicable to all rhythmic gymnastic floors that are to be used at any FIG-sanctioned event.

1.2 This specification does not imply that an injury cannot be incurred while using a rhythmic gymnastic floor which complies with this specification.

1.3 The test procedures associated with this standard may involve hazardous operations and equipment. This standard does not purport to address all the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to use.

2 Normative References

2.1 International Gymnastics Federation (FIG): Apparatus Rules: II-RG1.

2.2 European Standard: CEN 12503-5: Sport Mats – Determination of the Base Friction. 2000.

3 Terminology

3.1 *Description of terms specific to this standard:*

3.1.1 *Acceleration:* The instantaneous time rate of change of velocity, expressed in m/s^2, which may be positive or negative.

3.1.2 *Base plane:* The starting reference plane of the rhythmic gymnastic floor from which the total deflection and total height of rebound is determined. It is taken as the top plane of the test specimen.

3.1.3 *Dynamic deflection:* The measured distance (in mm) between the base plane and the maximum displacement of the impactor below the base plane.

3.1.4 *Force (F):* The product of the mass of the impactor, expressed in kg and the acceleration of the impactor, expressed in m/s^2.

3.1.5 *Maximum Force (F_{max}):* The maximum value of force measured during the impact expressed in Newtons.

3.1.6 *Height of rebound:* The measured distance (in mm) between the base plane and the maximum displacement of the impactor above the base plane.

3.1.7 *Impactor*: The striking part of the test apparatus.

3.1.8 *Impact velocity:* The velocity of the impactor, expressed in m/s, immediately prior to crossing the base plane on impact.

3.1.9 *Theoretical drop height:* A calculated drop height which equates the measured velocity of the impactor at the moment of dynamic impact to a height that would generate the same velocity if the test were performed at sea level and there was no friction to retard the impactor during a drop from that height.

3.1.10 *Static deflection:* The measured distance between the base plane and the displacement of the floor's surface at a defined distance from the centre of static indentation. Values are expressed as a percentage of the maximum deflection at the centre of indentation.

3.1.11 *Slider:* A test body of given mass and geometry. The slider includes a test sole which is bonded to the bottom of the slider and is made of synthetic material with defined friction properties.

3.1.12 *Thrust - traction sequence:* A series of 5 successive thrust and traction movements of the slider which is pushed and pulled horizontally on the surface of the test specimen at a defined speed and distance.

3.1.13 *Sliding distance:* The horizontal distance between the two turning points of the movement of the slider in a thrust – traction sequence.

3.1.14 *Mean thrust - traction force:* Mean value of the absolute, average force, expressed in Newtons, as the slider moves during the fifth push and pull movement in a thrust - traction sequence.

3.1.15 *Friction coefficient:* Quotient of the mean thrust - traction force (in N) and the weight of the slider (in N) in a thrust - traction sequence.

3.1.16 *Base temperature:* The surface temperature (in ^{0} C) of the test specimen immediately before the beginning of a thrust - traction sequence.

3.1.17 *Mean thrust - traction temperature:* Mean value of the surface temperature (in ^{0} C) of the test specimen at a defined distance to the slider during the fifth push and pull movement in a thrust - traction sequence.

3.1.18 *Temperature rise:* Difference (in ^{0} C) between the base temperature and the mean thrust - traction temperature in a thrust - traction sequence.

3.1.19 *Orthogonal difference of friction coefficients:* The absolute value of the difference between the mean value of the friction coefficients of 3 consecutive thrust - traction sequences in one measurement direction and the corresponding mean value of 3 additional consec-

utive thrust - traction sequences in a perpendicular measurement direction.

3.1.20 *Orthogonal difference of temperature rises:* The absolute value of the difference between the mean value of the temperature rises of 3 consecutive thrust - traction sequences in one measurement direction and the corresponding mean value of 3 additional consecutive thrust - traction sequences in a perpendicular measurement direction.

4 Principles of Measurement

4.1 *The complete test procedures include 3 parts:* Determination of shock absorption, determination of static stiffness and determination of top friction.

4.1.1 *Test A - Determination of shock absorption:* A test specimen is impacted with an impactor of given mass and geometry at a specified velocity. A transducer mounted in the impactor monitors the acceleration – time history of the impactor which is recorded with the aid of a data acquisition system. An additional transducer may be used to monitor the displacement – time history of the impactor.

4.1.2 *Test B - Determination of static stiffness:* A static load is applied to the rhythmic gymnastic floor to obtain an area of impression. The static deflection of the specimen's surface at defined distances from the centre of indentation is measured.

4.1.3 *Test C - Determination of top friction:* A slider of given mass and geometry traverses the test specimen which is fixed on a plane surface. The slider is pushed forward and pulled backwards for a specified number of times with a constant velocity over a given distance. Two transducers are mounted at the slider. One of them monitors the thrust and traction force - time history of the slider movement. The other captures the temperature - time history of the surface of the test piece in a defined distance to the slider.

4.2 Data obtained during these procedures are indicative of the cushioning and rebound properties, the static stiffness and the top friction characteristics of the rhythmic gymnastic floor used in training and FIG-sanctioned competitions.

5 Performance Requirements

5.1 *Test A - Determination of shock absorption:* When tested according to the procedures described in Section 9.1, the overall mean value of the measured variables across all impact sites shall be within the figures of Table 1.

Table 1: Figures for Test A - Determination of Shock Absorption

x represents the mean value of the measured variable

Dynamic deflection (mm)	***Height of rebound (mm)***	***F_{max} (N)***
x <= 27	120 <= x <= 180	≤ 3700

5.2 *Test B - Determination of static stiffness:* When tested according to the procedures described in Section 9.2, the measured variables shall be within the figures of Table 2.

Table 2: Figures for Test B - Determination of Static Stiffness

Distance to the centre of static indentation (cm)	0	5	6	8	10	12	14	16
Static deflection (%)	100	100	≥57	≥46	≥38	≥33	≥28	≥24
Distance to the centre of static indentation (cm)	18	20	22	24	26	28	30	32
Static deflection (%)	≥20	≥17	≥14	≥12	≥11	≥9	≥8	≥8

5.3 *Test C - Determination of top friction:* When tested according to the procedures described in Section 9.3, the measured variables shall be within the figures of Table 3.

Table 3: Figures for Test C - Determination of Top Friction

X represents the mean value of the measured variable

Friction coefficient	***Temperature rise (°C)***	***Orthogonal difference of friction coefficients***	***Orthogonal difference of temperature rises (°C)***
0.32≤ x ≤0.62	≤ 2.3	≤ 0.08	≤ 0.8

6 Test Set-up and Test Apparatus

6.1 *Test A - Determination of shock absorption:*

6.1.1 *Impact test machine:* Any type of dynamic testing apparatus that is capable of impacting a test specimen at a prescribed impact velocity and monitoring and recording the acceleration - time history of the impactor is acceptable. The impact test machine and the impactor shall have sufficient rigidity to eliminate undesirable vibrations in the apparatus which might be recorded on the acceleration - time curve. The impact test machine shall also be designed in such a manner that only the impact face contacts the test specimen at any time during the test procedures.

6.1.2 *Impactor:* The impactor shall be 10 kg ± 0.1 kg and shall have a flat impact face with a 10 cm ± 0.5 cm diameter. The edge of the impactor face should be relieved to eliminate sharp edges. Provision shall be made so that the accelerometer can be securely fastened parallel to the vertical axis of the impactor with a maximum deviation of ± 5°.

6.1.3 *Recording equipment* - The recording equipment shall meet the following criteria:

6.1.3.1 6.1.3.1 *Acceleration - time:* The selection of the specific acceleration - time recording equipment, including transducers and recorders, is at the discretion of the test laboratory. However, the recording system

shall have a frequency response adequate to measure the peak acceleration value to an accuracy of ± 5% of the true value. The total system, detection and recording, shall be capable of measuring impact accelerations of up to 100 g at frequencies from 2 to 1000 Hz to an accuracy of ± 5%. The minimum sampling rate of the data acquisition system shall be 5000 Hz.

6.1.3.2 6.1.3.2 *Displacement - time:* It is optional, but desirable, that the displacement - time history is recorded by a separate transducer. Any transducer that provides a linear signal proportional to the displacement of the impactor along the impact axis which can be monitored coincidentally with the acceleration - time trace is acceptable. If displacement is recorded, the test equipment shall have means to determine and record the top plane (base plane) of the test specimen from which the total dynamic deflection and rebound height are determined.

6.1.3.3 6.1.3.3 *Filtering:* The signal from all transducers shall be conditioned with a low pass filter which complies with Channel Class 1000 of SAE Recommended Practice J211. A fourth-order Butterworth low pass filter with a cut-off frequency of 1000 Hz meets this requirement.

6.2 *Test B – Determination of static stiffness:*

6.2.1 *Measurement device:* Any type of static testing apparatus that is capable of loading a test specimen with a given weight and monitoring and recording the static deflection at defined distances from the centre of static indentation is acceptable. The test apparatus, especially the part directly measuring the deflection, shall also be designed in such a manner that it does not contact the test specimen in a circular area of 0.8 m diameter around the centre of indentation at any time during the test procedures, except the impact face of the indentor.

6.2.2 *Static load:* The static load shall be 100 kg ± 1 kg, vertically applied by an indentor onto the test specimen. The indentor shall have a flat impact face with a 10 cm ± 0.5 cm diameter. The edge of the indentor face should be relieved to eliminate sharp edges.

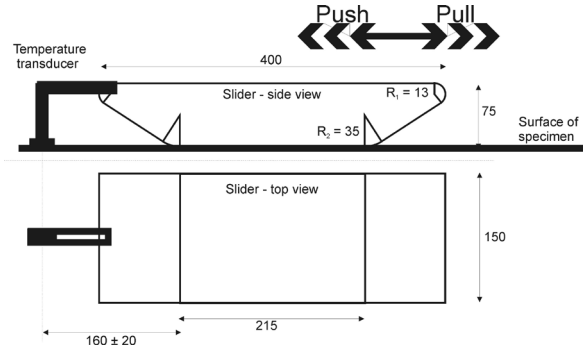
6.2.3 *Recording equipment for static deflection:* The selection of the specific measurement equipment is at the discretion of the test laboratory. However, the means of measuring the static deflection shall have a flat rectangular contact face of 47 mm * 31 mm ± 3%. The load on the surface of the test specimen by the weight of the measuring system shall be 2 N ± 3%. The accuracy of the system shall be ± 0.5 mm.

6.3 *Test C – Determination of top friction:*

6.3.1 *Measurement device:* Any type of friction testing apparatus that is capable of stressing a test specimen by pushing and pulling a slider on the specimen's surface at a given velocity and distance is acceptable. During the test the force – time history of the movement of the slider and the temperature – time history at the floor's surface shall be monitored and recorded. The friction test machine and the slider shall have sufficient rigidity to eliminate undesirable vibrations in the apparatus which might be recorded on the force - time curve. It is desirable to fix the test specimen for the friction tests with the help of an additional fastening system outside the sliding area.

6.3.2 *Slider:* The slider shall be made of wood with a mass of 9.5 kg ± 3% and shall have the geometrical dimensions specified in Figure 1. A test sole of synthetic material with a thickness of 2.6 mm ± 0.5 mm shall be bonded to the bottom of the slider, complying with the requirements of CEN 12503-5: $\alpha L := 47.5 \pm 0.5$. The temperature of the test specimen's surface shall be captured at a distance of 160 mm ± 20 mm to front edge of the flat part of the bottom of the slider (see Figure 1).

Figure 1: Slider Dimensions for Top Friction Tests of Rhythmic Gymnastic Floors.
(Dimensions in mm; Accuracy: ±1 mm)



6.3.3 The slider shall be pushed and pulled over a determined sliding distance a specified number of times at a given constant velocity.

6.3.4 *Recording equipment* - The recording equipment shall meet the following criteria:

6.3.4.1 *Force – time:* The selection of the specific force - time recording equipment, including transducer and recorder, is at the discretion of the test laboratory. The total system, detection and recording, shall be capable of measuring thrust and traction forces up to ± 1000 N at frequencies from 2 to 100 Hz to an accuracy of ± 3%. The minimum sampling rate of the data acquisition system shall be 200 Hz.

6.3.4.2 *Temperature – time:* The selection of the specific temperature - time recording equipment, including transducer and recorder, is at the discretion of the test laboratory. The transducer should have means to provide temperature measurements during sliding movements up to 300 mm/s. The time constant of the temperature transducer shall be $T_{99} \leq 4$ s. The thermoelectric transducer ANRITSU/AIRFLOW C423 meets these requirements. The total system, detection and recording, shall be capable of measuring temperature differences up to $+10^0$ C at frequencies from 2 to 100 Hz to an accuracy of ± 1%. The minimum sampling rate of the data acquisition system shall be 200 Hz.

7 Test Specimen

7.1 The test specimen submitted for testing shall represent the rhythmic gymnastic floor as it is intended to

be used during training and/or competition.

7.2 The test specimen shall comply with FIG Apparatus Rules: II-RG1. Exception: See 7.3.

7.3 The minimum horizontal dimensions (length * width) for any test specimen shall be 200 cm * 120 cm. For Test C (Determination of top friction) the minimum horizontal dimensions (length * width) for any test specimen shall be 100 cm * 120 cm.

8 Conditioning and Test Temperature

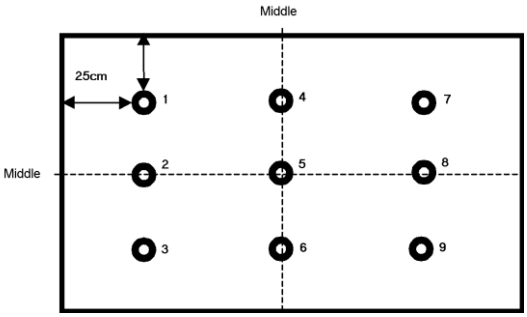
8.1 The test specimen shall be preconditioned at 50% ± 10% relative humidity and 21º ± 3º C for a minimum of 24 hours prior to the test. All testing shall be carried out under the same conditions.

9 Laboratory Procedures (Test Methods)

9.1 *Test A - Determination of shock absorption:*

9.1.1 Impact locations: A total of nine impact sites shall be designated on the test specimen. See Figure 2 for an illustration of the impact sites.

Figure 2: Impact Locations for Rhythmic Gymnastic Floors



9.1.2 *Impact test procedures:*

9.1.2.1 9.1.2.1 Place the test specimen under the impact test machine on a smooth, solid floor (concrete or metal plate) and orient the impactor such that the centre of the impact face will contact one of the designated impact test sites.

9.1.2.2 9.1.2.2 Raise the impactor to an appropriate drop height such that it will contact the test specimen with an impact velocity of 2.80 m/s ± 3 %. This corresponds to a theoretical drop height of 0.4 m.

9.1.2.3 9.1.2.3 Release the impactor and capture the acceleration - time history and displacement - time history (if applicable) using recording equipment described in Section 6.1.3.

9.1.2.4 9.1.2.4 Upon completion of a given impact test, raise the impactor off the surface of the test specimen.

9.1.2.5 9.1.2.5 The duration between tests at a given impact site shall not be less than 120 seconds.

9.1.2.6 9.1.2.6 Each test specimen shall receive a total of 90 impacts. Impact each of the nine impact sites ten times.

9.1.3 Calculations:

9.1.3.1 9.1.3.1 Immediately following each test, record the following measurements: F_{max} (N), Dynamic deflection (mm) and Height of rebound (mm).

9.1.3.2 9.1.3.2 The last eight tests for each impact site shall be used to determine the arithmetic mean value of a measured variable for each impact site and for the overall mean value of a measured variable across all impact sites.

9.2 *Test B - Determination of static stiffness:*

9.2.1 *Static impact test procedure:*

9.2.1.1 9.2.2.1 Place the test specimen under the impact test machine and orient the impactor such that it will contact the midpoint of the test specimen's surface. The test specimen shall lie on a smooth, solid floor (concrete or metal plate) for the test.

9.2.1.2 9.2.2.2 Apply the load on the test specimen's surface for 30 s. Measure and calculate the static deflection at the following distances from the centre of indentation: 0 cm; 5 cm; 6 cm; 8 cm; 10 cm; 12 cm; 14 cm; 16 cm; 18 cm; 20 cm; 22 cm; 24 cm; 26 cm; 28 cm; 30 cm and 32 cm.

9.2.1.3 9.2.2.3 Upon completion of the measurements unload the surface of the test specimen.

9.3 *Test C - Determination of top friction:*

9.3.1 Place the test specimen under the slider. Fix all components carefully with the fastening system to prevent horizontal movement of the test specimen during the friction test. The complete test specimen shall lie on a smooth and solid horizontal plate.

9.3.2 The slider shall be pushed and pulled with a constant velocity of 300 mm/s ± 3% over 90% of the total sliding distance of 600 mm ± 3%.

9.3.3 Perform a thrust – traction sequence with the slider (i.e. 5 pushing and pulling movements) within 30 sec. Capture the force – time history using recording equipment described in Section 6.3.4. Wait at least 300 seconds between trials. Repeat the whole thrust – traction sequence an additional two times with the pause between trials.

9.3.4 Repeat the procedure given in 9.3.3 to obtain readings in the perpendicular direction by rotating the test specimen through 90^0.

9.3.5 Upon completion of the measurements unload the surface of the test specimen.

9.3.6 Each test specimen shall receive a total of 6 thrust – traction sequences.

9.3.7 *Calculations:*

9.3.7.1 9.3.7.1 Immediately following the test, record and calculate the following measurements for every thrust – traction sequence: Friction coefficient and Temperature rise (^{0} C).

9.3.7.2 9.3.7.2 Determine the overall mean value of the measured variables for all thrust – traction sequences, the Orthogonal difference of friction coefficients and the Orthogonal difference of temperature rises.

9.4 Calculate the values of all required variables rounded to the decimal places of the corresponding figures identified in Section 5.

10 Report

10.1 The test report shall include the following infor-

mation:
10.1.1 Complete identification of the tested rhythmic gymnastic floor, including type, source, manufacturer's model number (if appropriate), dimensions of test specimen, and any other pertinent information. Photographs may be included in the test report for sample documentation purposes.
10.1.2 Test identification number according to the internal regulations between the FIG Test Institutes.
10.1.3 Complete identification of the testing laboratory including test technician and test laboratory manager (if appropriate).
10.1.4 Conditions of test, including test date, temperature and humidity.
10.1.5 Identification of performed parts of the test – Test A; Test B; Test C.
10.1.6 Description of the impactor mass and the drop height conditions (Test A), static load (Test B), mass, velocity and sliding distance of the slider (Test C).
10.1.7 Description of the test results relative to the performance requirements identified in Section 5.
10.1.8 Mean values of Deflection, Height of rebound and F_{max} across all impact sites according to Test A.
10.1.9 Maximum value, minimum value and standard deviation of Deflection, Height of rebound and F_{max} variables according to Test A.
10.1.10 Mean values of Deflection, Height of rebound and F_{max} for the last eight tests at each impact site according to Test A.
10.1.11 Deflection, Height of rebound and F_{max} values for all tests according to Test A.
10.1.12 Friction coefficient, temperature rise, Orthogonal difference of friction coefficients and Orthogonal difference of temperature rises for all thrust – traction sequences according to test C.

This standard is subject to revision at any time by the FIG Apparatus Commission. You are invited to comment on revision of this standard or on additional standards. Comments should be addressed to the FIG General Secretary

Apparatus Control Forms RG (Form B)

(for forms A: see FIG Apparatus Norms Part III)

IV
RG
01.01.2016
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Prior to every FIG Event in MAG, WAG, TRA and RG an apparatus control shall be scheduled before the first contact of athletes with the equipment. The completed forms have to be reported to the TC President or if she is not at the competitions site to the FIG Event Delegate and to the President of the FIG Apparatus Commission. According to the FIG event, different forms shall be used:

Form A: (FIG TC Delegate)
Competitions: World Cups, Continental Games (without FIG Apparatus Commissioner)

Main aspects for the apparatus control with form A:

- To be performed 1-2 h prior to the first contact of the athletes with the equipment.
- To be done for training hall (every set), warming up hall and competition hall.
- Control of specifications of the FIG Apparatus Manual.
- Judgment of non-described safety relevant aspects.
- Control of all adjustable heights, lengths etc. at the apparatuses.
- Control of all security relevant parts (fixings, stability and mats displacement).
- If necessary, monitoring of apparatus relevant ad hoc decisions of the TP / TC or other FIG Authorities.

Remark: Forms A are published in FIG Apparatus Norms Part III.

Form(s) B: (FIG Apparatus Commissioner)
Competitions: World Championships and Olympic Games (with FIG Apparatus Commissioner)

Main aspects for the apparatus control with forms B:

(IC) Intensive Control (FIG Apparatus Commissioner):
- To be done for training hall (every set), warming up hall and competition hall
- To be performed prior to the first contact of the athletes with the equipment
- Control of accordance of equipment with the tested Specimen
- Control of all specifications of the FIG Apparatus Manual
- Judgment of non-described safety relevant aspects
- Report of the results to the Technical President
- If necessary monitoring of apparatus relevant ad hoc decisions of the TP / TC or other FIG Authorities

(FC) Final Control (Technical Committee Member(s), FIG Apparatus Commissioner):
- To be performed immediately prior to the competition or the podium training.
- Control of all adjustable heights, lengths etc. at the apparatuses.
- Control of all security relevant parts (fixings, stability and mats displacement).

(LC) Daily Light Control (FIG Apparatus Commissioner):
- To be performed every day in all training and warming up halls.
- Control of accordance of the equipment with the time of the extensive control.
- Control of all adjustable heights, lengths etc. at the apparatuses.
- Control of all security relevant parts (fixings, stability and mats displacement).

Apparatus Control RG
(Intensive Control - Forms B)
(Forms A: see FIG Apparatus Norms Part III)

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RG
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APPARATUS CONTROL B (IC) - RHYTHMIC GYMNASTICS

Competition Logo

Competition: ***Name of the Competition***

Discipline: **RG** Site: Date:

General intensive Control (FIG Apparatus Manager)

RG1 Field of Play	**Stipulation**	**Result - Action**	
Concordance with test report:			
Surface area	width A (1300 ± 3 cm)		
	width B (1300 ± 3 cm)		
	diagonal A (1838 ± 5 cm)		
horizontal, even, without gaps			
Seams´ direction	Towards Judges (Training: Towards Coaches)		
Edge	horizontal (50cm); with slope (25-25cm)		
Clearance zone (without edge)	(200 cm)		
Delimitation strip or line	contrast, width (5 ± 0.5 cm)		
Minimum height of the hall	1000 - 1200 cm min		
RG1 Floor Nr X (Training)	**Stipulation**	**Result - Action**	
Concordance with test report:			
Surface area	width A (1300 ± 3 cm)		
	width B (1300 ± 3 cm)		
	diagonal A (1838 ± 5 cm)		
horizontal, even, without gaps			
Seams´ direction	Towards Judges (Training: Towards Coaches)		
Edge	~~horizontal (50cm)~~; with slope (25-25cm)		
Clearance zone (without edge)	(200 cm)		
Delimitation strip or line	contrast, width (5 ± 0.5 cm)		
Minimum height of the hall	1000 - 1200 cm min		
RG1 Floor general warm up	**Stipulation**	**Result - Action**	
Concordance with test report:			
Surface area	width A (1300 ± 3 cm)		
	width B (1300 ± 3 cm)		
	diagonal A (1838 ± 5 cm)		
horizontal, even, without gaps			
Seams´ direction	Towards Judges (Training: Towards Coaches)		
Edge	~~horizontal (50cm)~~; with slope (25-25cm)		
Clearance zone (without edge)	(200 cm)		
Delimitation strip or line	contrast, width (5 ± 0.5 cm)		
Minimum height of the hall	1000 - 1200 cm min		

Apparatus Control RG
(Intensive Control - Forms B)
(Forms A: see FIG Apparatus Norms Part III)

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RG10 Measurement Table 1	**Stipulation**	**Result - Action**	
suitable for measurement of diameters			
hoops	800 - 900 mm		
measurement of whole circle?			
balls	180 - 200 mm		
end of clubs	max. 30mm		
cane of ribbons	max. 10mm		
suitable for measurement of lengths:			
clubs	400 - 500 mm		
ribbons	5000mm Juniors (6000mm min. Seniors)		
doubled part of the ribbon	1000mm +/- 5 mm		
cane of ribbons	500 - 600 mm		
optional handle part of cane of ribbons	max. 100mm		
fixture of ribbons	70mm max.		
width of ribbons	40 - 60 mm		
suitable balance:			
precision	+/- 1g		
Hoops measurement	hanging position		
hoop / balls / clubs / ribbons without c	min. 300 / 400 / 150 / 35 g (30g Juniors)		
Indication	all measures indicated unmistakably		

Signature **Time & date**

Apparatus Control RG
(Intensive Control - Forms B)

(Forms A: see FIG Apparatus Norms Part III)

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RG
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Apparatus Control RG
(Final Control - Forms B)
(Forms A: see FIG Apparatus Norms Part III)

APPARATUS CONTROL B (FC) - RG GYMNASTICS

Competition Logo

Competition: ***Name of the Competition***

Discipline: **RG** Site: Date:

Final Control (FIG Apparatus Manager, TC Representatives, Delegate AC)

RG1 Floor	**Stipulation**	**Result - Action**
Concordance with test report:		
Surface area	width A (1300 ± 3 cm)	
	width B (1300 ± 3 cm)	
	diagonal A (1838 ± 5 cm)	
horizontal, even, without gaps		
Clearance zone	(200 cm)	
Delimitation strip	contrast, width (5 ± 0.5 cm)	
RG10 Measurement Table	**Stipulation**	**Result - Action**
Indication	all measures indicated unmistakably	

Signatures **Time & date**

Apparatus Control RG
(Final Control - Forms B)
(Forms A: see FIG Apparatus Norms Part III)

APPARATUS CONTROL B (LC) - RG GYMNASTICS

Competition Logo

Competition: ***RG Competition***

Discipline: **RG** Site: All Floors Date:

Light Control (FIG Apparatus Commissioner)

RG1 Floor	**Stipulation**	**Result - Action**
Surface areas		
horizontal, even, without gaps		
Additional		**Result - Action**
Light		
Safety distances		

Signature **Date & Time**

Apparatus Control RG
(Final Control - Forms B)

(Forms A: see FIG Apparatus Norms Part III)

Standard Specification: Trampolines

This standard is issued under the fixed designation FIG: IV-TRA1-01.01.2016; the numbers immediately following the designation indicate the date of original adoption by the FIG, or, in case of revision, the date of the last revision. This FIG standard was prepared by the Apparatus Commission of the FIG and participating FIG test laboratories and was adapted from the former International Trampoline Federation (FIT) standard for Trampolines (FIT Handbook 1998). This standard was originally published in English only.

Introduction

The objective of this FIG standard is to provide equal opportunities for all athletes in FIG competitions by controlling the functional properties of trampolines and to minimize any differences between competition and training equipment.

1 Scope

1.1 This specification covers the measurement of certain elastic properties of trampolines. This standard specification is applicable to all competition trampolines that are to be used at any FIG-sanctioned event.

1.2 This specification does not imply that an injury cannot be incurred while using a trampoline which complies with this specification.

1.3 The test procedures associated with this standard may involve hazardous operations and equipment. This standard does not purport to address all the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to use.

2 Normative References

2.1 International Gymnastics Federation (FIG): Apparatus Rules: II-TRA1.

3 Terminology

3.1 *Description of terms specific to this standard:*

3.1.1 *Base plane:* The reference plane of the trampoline from which the total deflection and total height of rebound is determined. It is taken as the plane of the trampoline bed.

3.1.2 *Vertical falling line*: The reference line in space, which corresponds to the vertical trajectory of a test sphere to the first impact on the trampoline.

3.1.3 *Reference point of the test sphere:* The bottom point of the test sphere in a defined spatial position.

3.1.4 *Deflection:* The vertically measured distance (in mm) from the base plane to the reference point of the test sphere at maximum displacement below the base plane caused by the first impact.

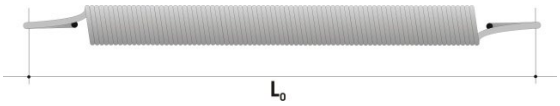
3.1.5 *Height of rebound:* The vertically measured distance (in mm) from the base plane to the reference point of the test sphere at maximum displacement above the base plane caused by the first rebound.

3.1.6 *Deviation from the middle axes to the side during rebound:* The measured horizontal distance (in mm) between the vertical falling line and the reference point of the test sphere at maximum displacement above the base plane (Height of rebound).

3.1.7 *Trampoline spring:* Most commonly (but not mandatory) the connection between the jumping bed and the frame is equipped by metallic tension coil springs with side hooks (see Figure 1). In this standard a test for *trampoline springs* is specified because all competition trampolines are equipped with this type of springs at the date of issue. If a trampoline is equipped with springs of different properties this standard refers to the springs which are mostly used as connection between the jumping bed and the frame.

3.1.8 *Length$_0$ (L_0)*: Length of an unloaded trampoline spring measured from one inner edge of the hook to the other (see Figure 1), expressed in mm.

Figure 1: Metallic tension coil spring with side hooks actually used with all competition trampolines.
Length$_0$ (L_0) is indicated as the distance between the two inner sides of the hooks measured with the unloaded trampoline spring.



3.1.9 *Length$_X$ (L_X)*: Length x of a trampoline spring lengthened by an elongating, corresponding force, measured from one inner edge of the hook to the other, expressed in mm.

3.1.10 $Mass_{ts}(m_{ts})$: The mass of a trampoline spring expressed in Grams (g).

3.1.11 $Spring\ constant_{ts}\ (D_{ts})$: The ratio $\frac{F}{\Delta L}$ (with $\Delta L > 0$) of a trampoline spring expressed in N/mm, at an elongation (ΔL) greater than zero.

3.1.12 $Average\ Spring\ constant_{ts}\ (\overline{D_{ts}})$: The average value of the spring constants$_{ts}$ during the elongation protocol (see 9.2.3; step test).

3.1.13 Tension$_{385;X}$: The force which is needed to elongate a trampoline spring from L_0 to the length of 385mm (length$_{385}$), expressed in Newtons (N). The value shall be measured at length$_{385}$ immediately after an elongation to X mm in a prescribed measurement protocol (see 9.2.3; step test).

3.1.14 *%tension$_{385;850}$* : The relative force which is

needed to elongate a trampoline spring to a length of 385mm (length$_{385}$), measured immediately after the trampoline spring was elongated to a length of 850mm (length$_{850}$) during a prescribed measurement protocol (step test, see 9.2.3). The value shall be expressed in % of *tension$_{385;385}$* using the formula: %tension$_{385;850}$ = (tension$_{385;850}$ * 100)/(tension$_{385;385}$).

4 Principle of Measurement

4.1 *The complete test procedure includes two parts:* One impact test to determine the rebound characteristics of the complete trampoline construction and a spring test to determine certain properties of the trampoline springs.

4.1.1 Impact test

4.1.1.1 The trampoline is impacted from a specified height with a spherical impactor of given mass and diameter. The three-dimensional displacement – time history of the impactor is monitored during the impact onto the bed and the first rebound after impact.

4.1.1.2 Displacement data obtained during these procedures are indicative of the elastic properties of the trampoline used in training and FIG-sanctioned competitions.

4.1.1 Spring test

4.1.1.1 A specific number of trampoline springs are lengthened according to a prescribed protocol (see 9.2.3; step test) and the force and elongation characteristics are recorded.

4.1.1.2 Changes of the force and elongation characteristics during a specific testing protocol (see 9.2.3; step test) are indicative of the characteristics of trampoline springs especially after elongations up to critical lengths (above 850mm) which can be reached during extensive usage of the trampoline.

5 Performance Requirements

5.1 When tested according to the impact test procedures described in Section 9.1, the mean value of the measured variables for each impact site shall be within the figures of Table 1.

Table 1: Figures for Trampolines

(Empty cells in table: no requirements;
x represents the mean value of the measured variable at an impact site)

Measurement point	Deflection (mm)	Height of rebound (mm)	Deviation **from the middle axes** during rebound (mm)
1	**940 ≤ x ≤ 1010**	**3310 ≤ x ≤ 3560**	**≤ 100**
2		**≤ 3560**	**1670 ≤ x ≤ 2020**

5.2 When tested according to the spring test procedures described in Section 9.2, the value for %tension$_{385;850}$ must be higher or equal 90% for all tested trampoline springs.

6 Test Apparatus

6.1 *Impact test set-up:* Any type of test set-up that is capable of impacting a trampoline under the prescribed conditions and monitoring and recording the displacement - time history of the reference point of the test sphere is acceptable. It is optional, but desirable, that the test sphere is released magnetically at the prescribed drop height.-

6.1.1 *Test sphere:* The test sphere shall be a metal sphere with a diameter of 40 cm ± 1 cm and a mass of 60 kg ± 0.5 kg To attach a magnetic fixation to the sphere, a flat plated upper section (up to a diameter of 10 cm) is acceptable.

6.1.2 *Recording equipment for the impact test* - The recording equipment shall meet the following criteria:

6.1.2.1 *Displacement - time:* It is at the discretion of the test laboratory to select a specific instrumentation to monitor, record and calculate the three-dimensional displacement of the sphere during impact and first rebound. The total system shall be capable of measuring height of rebound and deviation to the side during rebound with an accuracy of ± 1 cm and deflection with an accuracy of ± 0.5 cm. The requirements can be met by using at least three synchronized video cameras (min. frequency 200 Hz; min shutter speed 1/500) to capture the movements of the test sphere above the bed of the trampoline. The spatial motion of the test sphere can be calculated by three-dimensional cinematographic analysis utilizing the DLT - algorithm (Direct Linear Transformation) or a similar technique. The deflection may be determined by using one camera and two-dimensional cinematographic analysis.

6.2 *Trampoline spring test set-up*: Any type of set up which is capable of elongating a trampoline spring with a velocity of 100 mm/s (± 5 mm/s) and monitoring/recording the needed forces with corresponding elongation according to the prescribed protocol (see 9.2.3).

6.2.1 Recording equipment for the trampoline spring test:

Force: Any force - displacement recording equipment, including load cells and recorders, which can monitor the force exerted to the spring simultaneously with the elongation (displacement) is acceptable. The total system, detection and recording, shall be capable of measuring forces of up to 500 N to an accuracy of ± 3%. The sampling rate of the data acquisition system shall be 50 Hz (± 1Hz).

7 Test Specimen

7.1 The test specimen submitted for testing shall consist of a trampoline as it is intended to be used during training and/or competition with safety padding and

with at least one safety platform and at least five additional trampoline springs with the same properties as the springs used in the submitted trampoline.

7.2 The trampoline shall comply with FIG Apparatus Rules: II-TRA1.

8 Conditioning and Test Temperature

8.1 The trampoline mounted and assembled for use, shall be preconditioned at 50% ± 10% relative humidity and 21° C ± 3° C for a minimum of 24 hours prior to the test. All testing shall be carried out under the same conditions.

8.2 The trampoline springs shall be preconditioned at 50% ± 10% relative humidity and 21° C ± 3° C for a minimum of 24 hours prior to the test. All testing shall be carried out under the same conditions.

9 Laboratory Procedure (Test Method)

9.1 *Impact test procedures (please read "9.2.1 choosing of the test sample" before doing the impact test):*

9.1.1 *Impact locations:* A total of two impact sites shall be designated on the trampoline. See Figure 2 for an illustration of the impact sites.

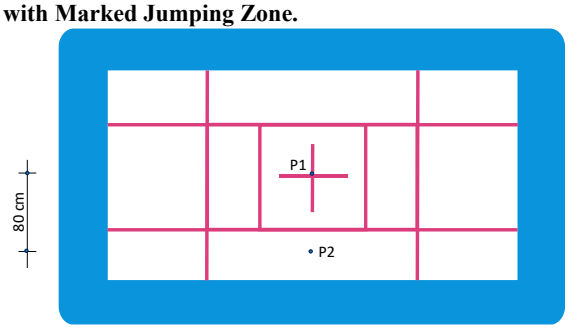
9.1.2 Place the test specimen on a smooth and solid floor and orient the impact test sphere so that the contact will be at one of the designated impact test sites.

9.1.3 Raise the test sphere to an appropriate drop height such that the distance between the reference point of the test sphere and the unloaded bed of the trampoline is 400 cm +/- 2 cm. ~~Allow the safety ropes (if used) to hang freely between the attachment points at the sphere down to the bed of the trampoline (see Figure 2 and Figure 3).~~

9.1.4 Release the test sphere and capture the displacement - time history using recording equipment described in Section 6.3.

9.1.5 Upon completion of a given impact test, raise the test sphere off the surface of the trampoline.

Figure 2: Impact Locations on the Bed for Trampolines with Marked Jumping Zone.



9.1.6 Check the displacement recordings after every test. If there is any deviation during the free fall of the test sphere (i.e. the test sphere did not hang absolutely still before release), the test shall be repeated.

9.1.7 Repeat the test procedures such that the trampoline to be tested shall receive five impacts at each of the two impact sites for a total of 10 impacts.

9.1.8 Calculations:

9.1.8.1 For each impact test, calculate the following measurements: Deflection (mm), Height of rebound (mm) and Deviation to the side during rebound (mm).

9.1.8.2 All five tests for each impact site shall be used to determine the arithmetic mean value of a measured variable for each impact site.

9.1.8.3 Calculate the mean values of Deflection, Height of rebound and Deviation to the side during rebound across all impact sites rounded to zero decimal places.

9.2 Spring test procedures:

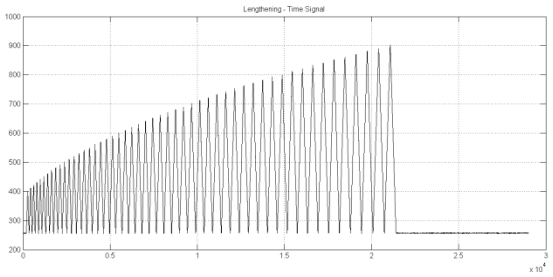
9.2.1 *Choosing the test samples*: Take one of the five additionally sent trampoline springs and put it as a reference in your archive. Then remove two trampoline springs from the trampoline and replace them by two of the additionally sent springs. Mark the two springs from the trampoline and the two additionally sent ones clearly, so that they are distinguishable. After the impact test (see 9.1) was finished, remove the two trampoline springs which are located closest to measurement point 4 of the impact tests. Mark these two springs clearly in a different manner than the two other types. In total you shall have six trampoline springs for the test. Run the following steps with each of them.

9.2.2 Take L_0 (see 3.1.8) and m_{ts} (see 3.1.10)

9.2.3 *Step test:* Enlongate the spring to a total length of 500mm and go back to the original length L_0 three times. Then start the step test: Whilst recording the force and lengthening start from L_0, elongate the spring to 400mm. Go back to the original length L_0. Then elongate the spring to 410mm and go back to the initial length L_0. For the third step elongate the spring to 420mm and go back to the initial length L_0. Keep incrementing the elongation by 10mm steps until the last 51st step with an elongation to 900mm. Then go back to L_0 and stop the test (see figure 4).

9.2.4 From the complete set of recorded force and elongation signals read both $tension_{385;385}$ and $tension_{385;850}$ and calculate: *%tension*$_{385;850}$ acoording to: $\%tension_{385;850} = (tension_{385;850} * 100)/(tension_{385;385})$. Furthermore, calculate the $\text{Average Spring constant}_{ts}$ ($\overline{D_{ts}}$) from the complete set of recorded force and elongation signals.

Figure 4: Example for testing of trampoline springs.
Step 1: Elongation from $Length_0$ (L_0) to 400mm.
Step 2: Elongation from $Length_0$ (L_0) to 410mm.
Step 3: Elongation from $Length_0$ (L_0) to 420mm.
.. Step 51: Elongation from $Length_0$ (L_0) to 900mm.
During lengthening the elongations are indicated. The corresponding forces are recorded.



10 Report

10.1 *The test report shall include the following information:*

10.1.1 Complete identification of the tested trampoline, including type, source, manufacturer's model number (if appropriate), dimensions of the trampoline, and any other pertinent information. Photographs may be included in the test report for sample documentation purposes. Test identification number according to the internal regulations between the FIG Test Institutes.

10.1.2 Identification of all tested trampoline springs, including type, mass, $length_0$, and average $spring\ constant_{ts}$.

10.1.3 Test identification number according to the internal regulations between the FIG Test Institutes.

10.1.4 Complete identification of the testing laboratory including test technician and test laboratory manager (if appropriate).

10.1.5 Conditions of test, including test date, temperature and humidity.

10.1.6 Description of the test sphere mass and the drop height conditions.

10.1.7 Description of the test results relative to the performance requirements identified in Section 5.

This standard is subject to revision at any time by the FIG Apparatus Commission. You are invited to comment on revision of this standard or on additional standards. Comments should be addressed to the FIG General Secretary.

Standard Specification: Tumbling Tracks

This standard is issued under the fixed designation FIG: IV-TRA3-01.07.1996; the numbers immediately following the designation indicate the date of original adoption by the FIG, or, in case of revision, the date of the last revision. This FIG standard was prepared by the Apparatus Commission of the FIG and participating FIG test laboratories and was adapted from the former International Trampoline Federation (FIT) standard for Tumbling Tracks (FIT Handbook 1998). This standard was originally published in English only.

Introduction

The objective of this FIG standard is to provide equal opportunities for all athletes in FIG competitions by controlling the functional properties of tumbling tracks and to minimize any differences between competition and training equipment.

1 Scope

1.1 This specification covers the measurement of certain shock-absorbing, rebound, top friction and stability characteristics of tumbling tracks. This standard specification is applicable to all tumbling tracks that are to be used at any FIG-sanctioned event.

1.2 This specification does not imply that an injury cannot be incurred while using a tumbling track which complies with this specification.

1.3 The test procedures associated with this standard may involve hazardous operations and equipment. This standard does not purport to address all the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to use.

2 Normative References

2.1 Society of Automotive Engineers: SAE J211 Recommended Practice for Instrumentation for Impact Tests – Requirements for Channel Class 1000, October 1988.

2.2 International Gymnastics Federation (FIG): Apparatus Rules: II-TRA3.

2.3 European Standard: CEN 12503-5: Sport Mats – Determination of the Base Friction. 2000.

3 Terminology

3.1 *Description of terms specific to this standard:*

3.1.1 *Acceleration:* The instantaneous time rate of change of velocity, expressed in m/s^2, which may be positive or negative.

3.1.2 *Base plane:* The starting reference plane of the tumbling track from which the total height of rebound is determined. It is taken as the top plane of the tumbling track.

3.1.3 *Force (F):* The product of the mass of the impactor, expressed in kg, and the acceleration of the impactor, expressed in m/s^2.

3.1.4 *Maximum Force (F_{max}):* The maximum value of force measured during the impact and expressed in Newtons.

3.1.5 *Height of rebound:* The calculated distance (in mm) between the base plane and the maximum vertical displacement of the impactor above the base plane under idealized frictionless conditions.

3.1.6 *Impactor:* The striking part of the test apparatus.

3.1.7 *Slider:* A test body of given mass and geometry. The slider includes a test sole which is bonded to the bottom of the slider and is made of synthetic material with defined friction properties.

3.1.8 *Thrust - traction sequence:* A series of 5 successive thrust and traction movements of the slider which is pushed and pulled horizontally on a surface of the test specimen at a defined speed and distance.

3.1.9 *Sliding distance:* The horizontal distance between the two turning points of the movement of the slider in a thrust – traction sequence.

3.1.10 *Mean thrust - traction force:* Mean value of the absolute, average force, expressed in Newtons, as the slider moves during the fifth push and pull movement in a thrust - traction sequence.

3.1.11 *Friction coefficient:* Quotient of the mean thrust - traction force (in N) and the weight of the slider (in N) in a thrust - traction sequence.

4 Principles of Measurement

4.1 *The complete measurement is composed of two specific test procedures:*

4.1.1 *Test A - Impact test:* A test specimen is impacted with an impactor of given mass and geometry from a specified drop height. A transducer mounted inside the impactor monitors the acceleration – time history of the impactor which is recorded with the aid of a data acquisition system.

4.1.2 *Test B - Determination of top friction:* A slider of given mass and geometry traverses the test specimen which is fixed on a plane surface. The slider is pushed forward and pulled backwards for a specified number of times with a constant velocity over a given distance. A transducer mounted at the slider monitors the thrust and traction force - time history of the slider movement.

4.2 Dynamic data obtained during these procedures are indicative of the cushioning and rebound (Test A) and top friction (Test B) properties of tumbling tracks used in training and FIG-sanctioned competitions.

5 Performance Requirements

5.1 *Test A - Impact test:* When tested according to the procedures described in Section 9.1, the overall mean values of the measured variables across all impact sites shall be within the figures of Table 1.

Table 1: Figures for Test A – Impact Test

Height of rebound (mm)	F_{max} *(N)*
≥ 550	≤ 6500

5.2 *Test B - Top friction:* When tested according to the procedures described in Section 9.2, the mean value of the measured variable shall be within the figure of Table 2.

Table 2: Figures for Test B – Top Friction

Friction coefficient
≥ 0.45

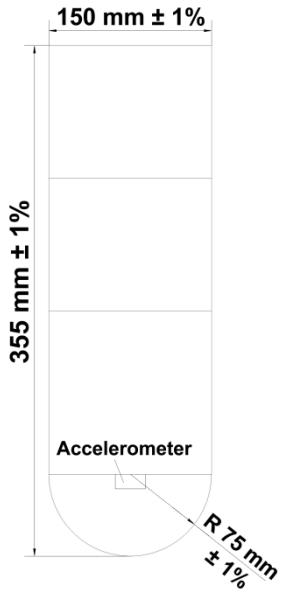
6 Test Apparatus

6.1 *Test A - Impact test procedures*:

6.1.1 *Impact test machine:* Any type of dynamic testing apparatus that is capable of impacting a test specimen with an impactor from a prescribed drop height and monitoring and recording the acceleration - time history of the impactor is acceptable. The impact test machine shall be designed in such a manner that only the impact face contacts the test specimen at any time during the test procedures. It is optional, but desirable, that the impactor is released from a magnet.

6.1.2 *Impactor:* The impactor shall consist of a cylindrical test body with a mass of 30 kg ± 0.3 kg and a geometry as specified in Figure 1. The accelerometer shall be rigidly mounted on the impactor as indicated in Figure 1.

Figure 1: Geometry of Impactor



6.1.3 *Recording equipment* - The recording equipment shall meet the following criteria:

6.1.3.1 *Acceleration - time:* The selection of the specific acceleration - time recording equipment, including transducer and recorder, is at the discretion of the test laboratory. However, the recording system shall have a frequency response adequate to measure the peak acceleration value to an accuracy of ± 5% of the true value. The total system, detection and recording, shall be capable of measuring impact accelerations of up to 100 g at frequencies from 2 to 1000 Hz to an accuracy of ± 5%. The minimum sampling rate of the data acquisition system shall be 5000 Hz.

6.1.3.2 *Filtering:* The signal from the transducer shall be conditioned with a low pass filter which complies with Channel Class 1000 of SAE Recommended Practice J211. A fourth-order Butterworth low pass filter with a cut-off frequency of 1000 Hz meets this requirement.

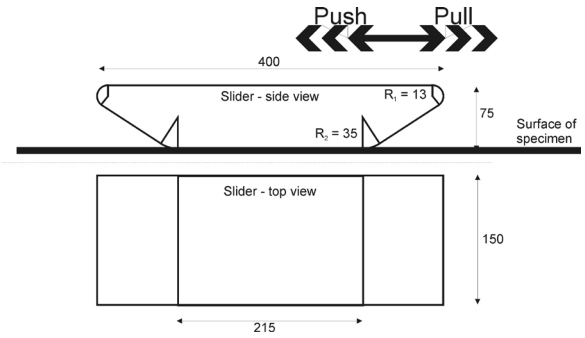
6.2 *Test B - Top friction:*

6.2.1 *Measurement device:* Any type of friction testing apparatus that is capable of stressing a test specimen by pushing and pulling a slider on the test specimen's surface at a given velocity and distance is acceptable. During the test the force – time history of the movement of the slider shall be monitored and recorded. The friction test machine and the slider shall have sufficient rigidity to eliminate undesirable vibrations in the apparatus which might be recorded on the force - time curve. It is desirable to fix the test specimen for the friction tests with the help of an additional fastening system outside the sliding area.

6.2.2 *Slider:* The slider shall be made of wood with a mass of 9.5 kg ± 3% and shall have the geometrical dimensions specified in Figure 2. A test sole of synthetic material with a thickness of 2.6mm ± 0.5 mm shall

be bonded to the bottom of the slider, complying with the requirements of CEN 12503-5: aL := 47.5 ± 0.5.

Figure 2: Slider Dimensions for Top Friction Tests
(Dimensions in mm; Accuracy: ±1 mm)



6.2.3 The slider shall be pushed and pulled over a determined sliding distance a specified number of times at a given constant velocity.

6.2.4 *Recording equipment* - The recording equipment shall meet the following criteria:

6.2.4.1 *Force – time:* The selection of the specific force - time recording equipment, including transducer and recorder, is at the discretion of the test laboratory. The total system, detection and recording, shall be capable of measuring thrust and traction forces up to ± 1000 N at frequencies from 2 to 100 Hz to an accuracy of ± 3%. The minimum sampling rate of the data acquisition system shall be 200 Hz.

7 Test Specimen

7.1 The test specimen submitted for testing shall represent the tumbling track as it is intended to be used during training and/or competition.

7.2 The test specimen shall comply with FIG Apparatus Rules: II-TRA3. Exception: See 7.3.

7.3 The minimum horizontal dimensions (width * length) for any test specimen shall be 170 cm * 120 cm.

8 Conditioning and Test Temperature

8.1 The test specimen shall be preconditioned at 50% ± 10% relative humidity and 21° C ± 3° C for a minimum of 24 hours prior to the test. All testing shall be carried out under the same conditions.

9 Laboratory Procedure (Test Method)

9.1 *Test A - Impact test:*

9.1.1 *Impact locations:* A total of seven impact sites shall be designated on the test specimen. See Figure 3 for an illustration of the impact sites.

9.1.2 *Impact test procedures*:

9.1.2.1 Place the test specimen under the impact test machine on a smooth, solid floor (concrete or metal plate) and orient the impactor such that the centre of the impact face will contact one of the designated impact test sites.

9.1.2.2 Raise the impactor to the drop height of 1.20 m □ 3%.

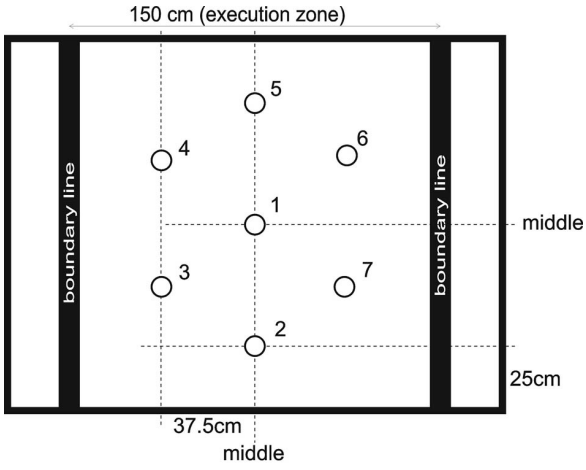
9.1.2.3 Release the impactor and capture the acceleration - time history using recording equipment described in Section 6.1.3.

9.1.2.4 Upon completion of a given impact test, raise the impactor off the surface of the test specimen.

9.1.2.5 The duration between tests at a given impact site shall not be less than 120 seconds.

9.1.2.6 Each test specimen shall receive a total of 70 impacts. Impact each of the seven impact sites ten times.

Figure 3: Impact Locations for Tumbling Tracks



9.1.3 *Calculations*:

9.1.3.1 Immediately following each test, calculate and record the following measurements: F_{max} (N) and Height of rebound (mm).

9.1.3.2 The last eight tests for each impact site shall be used to determine the arithmetic mean value of a measured variable for each impact site and for the overall mean value of a measured variable across all impact sites.

9.2 *Test B - Top Friction:*

9.2.1 Place the test specimen under the slider. Fix all components carefully with the fastening system to prevent horizontal movement of the test specimen during the friction test. The complete test specimen shall lie on a smooth and solid horizontal plate.

9.2.2 The slider shall be pushed and pulled parallel to the boundary lines of the tumbling track with a constant velocity of 300 mm/s ± 3% over 90% of the total sliding distance of 600 mm ± 3%.

9.2.3 Perform a thrust – traction sequence with the slider (i.e. 5 pushing and pulling movements) within 30 sec. Capture the force – time history using recording equipment described in Section 6.2.4. Wait at least 300 seconds between trials. Repeat the whole thrust – traction sequence an additional two times with the pause between trials.

9.2.4 Calculations:

9.2.4.1 Immediately following the test, record and calculate the friction coefficient for every thrust – trac-

tion sequence.

10 Report

10.1 *The test report shall include the following information:*

10.1.1 Complete identification of the tested tumbling track, including type, source, manufacturer's model number (if appropriate), dimensions of test specimen, and any other pertinent information. Photographs may be included in the test report for sample documentation purposes.

10.1.2 Test identification number according to the internal regulations between the FIG Test Institutes.

10.1.3 Complete identification of the testing laboratory including test technician and test laboratory manager (if appropriate).

10.1.4 Conditions of test, including test date, temperature and humidity.

10.1.5 *Test A - Impact Test*:

10.1.5.1 Description of the impactor mass and the drop height conditions.

10.1.5.2 Description of the test results relative to the performance requirements identified in Section 5.1.

10.1.5.3 Mean values of height of rebound and F_{max} across all impact sites.

10.1.5.4 Maximum value, minimum value and standard deviation of height of rebound and F_{max} variables.

10.1.5.5 Mean values of height of rebound and F_{max} for the last eight tests at each impact site

10.1.5.6 Height of rebound and F_{max} for all tests.

10.1.6 *Test B - Top Friction:*

10.1.6.1 Description of the mass, velocity and sliding distance of the slider.

10.1.6.2 Friction coefficients for all thrust – traction sequences.

Standard Specification: Vaulting Boards for Tumbling

This standard is issued under the fixed designation FIG: IV-ACRO11-01.01.06; the numbers immediately following the designation indicate the date of original adoption by the FIG or, in case of revision, the date of the last revision. This FIG standard was prepared by the Apparatus Commission of the FIG and participating FIG test laboratories. This standard was originally published in English only.

The standard specifications for vaulting boards for tumbling are the same as for men artistic gymnastics, therefore, this standard refers to the FIG standard IV-MAG14.

See:

IV
MAG 14
01.01.2015
1-3

This standard is subject to revision at any time by the FIG Apparatus Commission. You are invited to comment on revision of this standard or on additional standards. Comments should be addressed to the FIG General Secretary

Standard Specification: Time Measurement Devices (TMD) for Trampoline Competitions

This standard is issued under the fixed designation FIG: IV-TRA15-01.04.2026; the numbers immediately following the designation indicate the date of original adoption by the FIG, or, in case of revision, the date of the last revision. This FIG standard was prepared by the Apparatus Commission of the FIG and participating FIG test laboratories. This standard was originally published in English only.

Introduction

The objective of this FIG standard is to provide equal opportunities for all athletes in FIG competitions by controlling the functional properties of time measurement devices (TMD) intended to be used by judges at trampoline competitions.

1 Scope

1.1 This specification covers the technical control of the sensors and the measurement of the internal, mathematical treatment of time characteristics of a TMD. This standard specification is applicable to all TMDs that are to be used at any FIG-sanctioned trampoline event.

1.2 This specification does not imply that an injury cannot be incurred while using a TMD which complies with this specification.

1.3 The test procedures associated with this standard may involve hazardous operations and equipment. This standard does not purport to address all the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to use.

1.4 Different measuring methods result in two variants of the TMD. TMD variant A: Measurements up to 10 cm below the unloaded trampoline bed (e.g. through photoelectric barriers along defined measurement lines). TMD Variant B: Measurements relative to the unloaded surface of the trampoline bed. This variant can be used, for example, in combination with other measuring devices (HDMD - TRA 16).

This specification covers TMD variant A only.

2 Normative References

2.1 International Gymnastics Federation (FIG): Apparatus Norms; Part II - TRA15.

3 Terminology

Description of terms specific to this standard:

3.1 *Simulating Machine:* An electronic device which is capable of presenting specific time - related output signals i.e. in Transistor-Transistor-Logic Level (+5V – TTL) Format or any other specific solution which is capable to be used as simulation of signals from sensors. These signals are intended to provoke the same reactions of the TMD's central unit as with real signals from the TMD's sensors.

3.2 *Time Difference in Landing:* A Time interval corresponding to one skill of synchronized trampoline exercises. The value has to be measured at the landing after the same synchronous jump between the Ending Point at Foot Contact of the first athlete and the Ending Point at Foot Contact of the partner, expressed in seconds rounded down to the next lower multiple of 0,005 s (e.g.: All values less than 0.005 s are rounded to 0.000 s, all values equal or higher than 0.005 s and less than 0.01 s are rounded to 0.005 s).

3.3 *Given Time Difference:* Time interval i.e. coded as TTL-formatted-Signal generated by a Simulating machine to provoke the measurement of a Time Difference in Landing with a connected TMD central unit. The value shall be given in 1/1000 s.

3.4 *Rounded Sum of Deduction; Synchronization Score:* See definitions in: International Gymnastics Federation (FIG): *Apparatus Norms; Part II - TRA15*.

3.5 *Time of Flight:* A Time interval corresponding to one skill of an individual trampoline exercise. The value has to be measured during the flight phase of a jump between a Starting Point at Foot Contact and a succeeding Ending Point at Foot Contact, expressed in seconds rounded down to the next lower multiple of 0,005 s. (e.g.: All values less than 0.005 s are rounded to 0.000 s, all values equal or higher than 0.005 s and less than 0.01 s are rounded to 0.005 s).

3.6 *Given Time of Flight:* Time interval, i.e. coded as TTL-formatted-Signal generated by a Simulating machine, to provoke the measurement of a Time of Flight with a connected TMD central unit. The value shall be given in 1/1000 s.

3.7 *Time of Flight Score:* Sum of all measured Time of Flights for all elements during an exercise of an individual competition beginning with the first skill, rounded down to 1/100 and expressed in seconds. This value in seconds is equivalent to the score for the total time of flight in points.

4 Principle of the Test or Inspection

4.1 Inspection of the operation of the whole equipment according to the general requirements of a TMD described in *TRA15 of FIG Apparatus Norms Part II*. (Modes, specific requirements, technical features).

4.2 Inspection of the technology of the sensors by checking the construction, configuration and the technical specifications of the used electronic components.

4.3 Testing of the TMD´s central unit for correct treatment of input signals according to the definitions described in *TRA15 of FIG Apparatus Norms Part II*. The test has to be conducted by a simulating machine which simulates defined input signals of the sensors

during a synchronized exercise and an individual exercise.

5 Performance Requirements

5.1 When inspected according to the procedures described in section 9.1, the whole TMD has to react according to the general requirements for a TMD described in *TRA15 of FIG Apparatus Norms Part II*. (Modes, specific requirements, technical features).

5.2 When inspected according to the procedures described in section 9.2, the sensors and their connection to the TMD's central unit shall offer sufficient electronical capacity to fullfill the general requirements for a TMD described in *TRA15 of FIG Apparatus Norms Part II*.

5.3 When tested according to the procedures described in section 9.3 with "Given Times" as defined in 6.3.1 and 6.4.1, the maximal deviations between the intended and calculated values of the simulating machine and the tested TMD central unit shall not be greater than the values given in tables 1 and 2:

Table 1: Figures for testing the "Synchro" - Mode (Given Time Differences in Landing).

4 different simulations of complete exercises (10 Skills)
Each simulated exercise shall be tested 5 times.

Simulating Files 1.1 to 1.4 (each n= 5)			
Single Skills	Time Difference	P	Tot. Synch Score
Maximal deviation	0,005	0,020	0,050
Full Exercise			Tot. Synch Score
Maximal deviation			0,050

Table 2: Figures for testing the "Flight Time" - Mode (Given Flight Times).

2 different simulations of complete exercises (10 Skills)
Each simulated exercise shall be tested 5 times.

Simulating Files 2.1 and 2.2 (each n= 5)		
Single Skills	Times of Flight (rounded down)	Total Time of Flight [Score]
Maximal deviation	0,005	0,050
Full Exercise		Total Time of Flight [Score]
Maximal deviation		0,050

6 Simulating Machine

6.1 *Computerized Signal Generator:* Any type of electronic device that is capable of generating specific, time - related output signals i.e. in TTL level (+5V). The signals are intended to simulate the TMD's sensors input. If necessary, the signals have to be adjusted to the input of the TMD's central unit by a special adapter.

6.2 *Specification of the simulation signals:* Each channel has to represent one sensor signal of the TMD. The error of the time characteristics of the simulation signals shall not be greater than ± 1.5 ms for each channel.

6.3 *Time characteristics for the synchronized exercises:* The simulation signals have to cover all the specific treatment of time values according to the given examples in the part "Definitions" in *TRA15 of FIG Apparatus Norms Part II*. For this purpose, four simulation exercises with given time differences for each skill are defined for testing the "Synchro"-mode.

6.3.1 Synchronized Measurements:

Tables 3 - 6: Simulation Exercises for testing the "Synchro" - Mode (Given Time Differences in Landing).

Testfile 1.1 SYNCH
Simulating machine

Skill	Time Difference	P	Tot. Sync. score [points]
1	0,0150	0,03	0,97
2	0,0350	0,08	1,88
3	0,1200	0,30	2,58
4	0,2950	0,73	2,84
5	0,4300	routine stopped	
6	0,0300	0,07	
7	0,0050	0,01	
8	0,1150	0,28	
9	0,0050	0,01	
10	0,0100	0,02	

Testfile 1.2 SYNCH
Simulating machine

Skill	Time Difference	P	Tot. Sync. score [points]
1	0,0100	0,02	0,98
2	0,0050	0,01	1,97
3	0,0050	0,01	2,95
4	0,0050	0,01	3,94
5	0,0050	0,01	4,93
6	0,0090	0,01	5,92
7	0,2000	0,50	6,42
8	0,2050	0,51	6,90
9	0,3000	0,75	7,15
10	0,0100	0,02	8,13
			8,13

Testfile 1.3 SYNCH
Simulating machine

Skill	Time Difference	P	Tot. Sync. score [points]
1	0,0200	0,05	0,95
2	0,0200	0,05	1,90
3	0,0200	0,05	2,85
4	0,0200	0,05	3,80
5	0,0200	0,05	4,75
6	0,0200	0,05	5,70
7	0,0200	0,05	6,65
8	0,0200	0,05	7,60
9	0,0200	0,05	8,55
10	0,0200	0,05	9,50
			9,50

Testfile 1.4 SYNCH
Simulating machine

Skill	Time Difference	P	Tot. Sync. score [points]
1	0,0100	0,02	0,98
2	0,0095	0,01	1,97
3	0,0110	0,02	2,94
4	0,0190	0,03	3,90
5	0,0200	0,05	4,85
6	0,0260	0,06	5,79
7	0,0200	0,05	6,74
8	0,3000	0,75	6,99
9	0,1990	0,48	7,50
10	0,2050	0,51	7,99
			7,99

6.4 *Time characteristics for the individual exercises:* The simulation signals have to cover all the specific treatment of time values according to the given examples in the part "Definitions" in *TRA15 of FIG Apparatus Norms Part II*. For this purpose, two simulation exercises with given flight times for each skill are defined for "Flight Time" - Mode.

6.4.1 *Flight Time measurements:*

Tables 7 - 8: Simulation Exercises for testing the "Flight Time" - Mode (Given Flight Times).

Testfile 2.1 **Trial 1** **Individual**
Simulating machine

Skill	Given Times of Flight [s]	*Times of Flight (rounded down) [s]*	*Total Time of Flight [s]*
1	1,6530	1,650	1,650
2	1,7230	1,720	3,370
3	1,2450	1,245	4,615
4	1,2000	1,200	5,815
5	1,5670	1,565	7,380
6	1,6830	1,680	9,060
7	1,2680	1,265	10,325
8	1,4780	1,475	11,800
9	1,2030	1,200	13,000
10	1,0000	1,000	14,000
			14,000

Time of Flight Score: 14,00

Testfile 2.2 **Trial 2** **Individual**
Simulating machine

Skill	Given Times of Flight [s]	*Times of Flight (rounded down) [s]*	*Total Time of Flight [s]*
1	1,6510	1,650	1,650
2	1,7230	1,720	3,370
3	1,7470	1,745	5,115
4	1,6890	1,685	6,800
5	1,5670	1,565	8,365
6	1,6830	1,680	10,045
7	1,6680	1,665	11,710
8	1,4780	1,475	13,185
9	1,5292	1,525	14,710
10	1,4980	1,495	16,205
			16,205

Time of Flight Score: 16,20

7 Equipment which has to be submitted for testing

7.1 The test specimen submitted for testing shall represent the TMD as it is intended to be used during training and/or competition for synchronized and individual exercises, including hard- and software to transfer results to a computer.

7.2 The test specimen shall comply with *TRA15 of FIG Apparatus Norms Part II*.

7.3 If necessary, a specific adapter and all special connectors must be delivered in order to allow a correct connection between a simulating machine and the TMD's central unit.

7.4 All compartments (soft- and hardware) shall be submitted with a full technical documentation written in English.

7.5 For the identification of the used electronic components all units shall offer an easy possibility to open the chassis without damaging any part.

8 Conditioning and Test Temperature

Test specimens shall be preconditioned at 50% ± 10% relative humidity and 21° C ± 3° C for a minimum of 24 hours prior to the test. All testing shall be carried out under the same conditions.

9 Laboratory Procedure (Inspections and Test Methods)

9.1 *Inspection of the operation of the whole equipment:* Establish the equipment as intended for use with the sensors attached to a trampoline or to fasteners with equivalent distances. Inspect all modes, specific requirements and technical features which are prescribed for a TMD in *TRA15 of FIG Apparatus Norms Part II* by triggering the system at the sensors with appropriate actions. Document all observed deviations from the designated requirements.

9.2 *Inspection of the technology of the sensors:* Inspect the sensors and their connections by comparing it with the associated technical specifications of the original equipment manufacturers of the used electronic components. The inspections shall mainly cover the accuracy of the compartments with respect to the technical features which are prescribed for a TMD in *TRA15 of FIG Apparatus Norms Part I*.

9.3 *Test of the central unit of the TMD:* Connect the simulation machine and the central unit of the TMD. For testing the "Synchro" – Mode provokes the four simulating input files according to tables 3 to 6 with 5 trials for each "exercise". Record the output of the TMD´s central unit with an appropriate computer and calculate any differences between the given input files and the response of the TMD. Evaluate the results using table 1.

For testing the "Individual" – Mode provokes the two simulating input files according to tables 7 and 8 with 5 trials for each "exercise". Record the output of the TMD´s central unit with an appropriate computer and calculate any differences between the given input files and the response of the TMD. Evaluate the results us-

ing table 2.

10 Report

The test report shall include the following information:

10.1 Complete identification of the tested TMD, including type, source, manufacturer's model number (if available) and any other pertinent information. Photographs may be included in the test report for sample documentation purposes.

10.2 Test identification number according to the internal regulations between the FIG Test Institutes.

10.3 Complete identification of the testing laboratory including test technician and test laboratory manager (if available).

10.4 Conditions of test, including test date, temperature and humidity.

10.5 Description of the simulating machine and the signals specification.

10.6 Description of the test results relative to the performance requirements identified in section 5.

10.7 Any deviation between the intended and calculated values of the simulating machine and the tested TMD central unit.

This standard is subject to revision at any time by the FIG Apparatus Commission. You are invited to comment on revision of this standard or on additional standards. Comments should be addressed to the FIG General Secretary.

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Standard Specification: Horizontal Displacement Measurement Devices (HDMD) for Trampoline Competitions

This standard is issued under the fixed designation FIG: IV-TRA16-01.04.2026; the numbers immediately following the designation indicate the date of original adoption by the FIG, or, in case of revision, the date of the last revision. This FIG standard was prepared by the Apparatus Commission of the FIG and participating FIG test laboratories. This standard was originally published in English only.

Introduction

The objective of this FIG standard is to provide equal opportunities for all athletes in FIG competitions by controlling the functional properties of horizontal displacement measurement devices (HDMD) intended to be used by judges at trampoline competitions.

1.Scope

1.1 This specification covers the technical control of the sensors and the measurement of the internal, mathematical treatment of horizontal displacement characteristics of a HDMD. This standard specification is applicable to all HDMDs that are to be used at any FIG-sanctioned trampoline event.
1.2 This specification does not imply that an injury cannot be incurred while using a HDMD which complies with this specification.
1.3 The test procedures associated with this standard may involve hazardous operations and equipment. This standard does not purport to address all the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to use.
1.4 The test procedures associated with this standard only include checking the accuracy of the horizontal displacement. The verification of the correct allocation of deductions in accordance with the requirements of the TRA Code of Points is carried out by a TC member appointed by the TC President (see Part II TRA 16 page 3 - Procedures for Approval) and is not part of this regulation.

2 Normative References

2.1 International Gymnastics Federation (FIG): Apparatus Norms; Part II - TRA16.

3 Terminology

Description of terms specific to this standard:
3.1 Measuring plane: The surface of an unloaded trampoline's bed with a Cartesian coordinate system (in cm) and the center of the trampoline's bed as origin.
3.2 Measurement point (MP): Intersection of a line representing the direction of the movement of the test sphere's mass during the drop and the measuring plane.
3.3 Reference point of the test sphere: The bottom point of the test sphere in a defined spatial position.
3.4 Horizontal Displacement: Horizontal coordinates of the measurement point (MP) at the first contact with the measuring plane after a drop. The values shall be expressed as xy – coordinates (in meters) relative to the center of the trampoline's bed.

4 Principle of the Test

The complete test includes drop tests with a sphere to validate the measurement quality of the device for vertical impacts. If design differences (e.g. leg constructions) of certified trampolines at the time of the test can influence the measurement of the horizontal displacement, this test must be repeated for each type of design.
4.1 Impact tests
4.1.1 The trampoline is impacted vertically from a specified height with a spherical impactor of given mass and diameter. The three-dimensional displacement of the impactor is monitored during the fall and the impact onto the bed.
4.1.2 Differences between Horizontal Displacement data of the HDMD and the measured coordinates obtained during these procedures are indicative for the precision of the HDMD for vertical landings during training and FIG-sanctioned competitions.

5 Performance Requirements

When tested according to the procedures described in section 9 the maximal deviations between the data obtained by the prescribed procedures and the coordinates given by the tested HDMD the maximum shall not be greater than +10 cm and the mean shall not be greater than +5 cm for the impact tests.

6 Test Apparatus

Impact test set-up: Any type of test set-up that is capable of impacting a trampoline under the prescribed conditions and monitoring and recording the horizontal displacement of the reference point of the test sphere at impact is acceptable. It is optional, but desirable, that the test sphere is released magnetically at the prescribed drop height. ~~In addition, it is recommended to attach safety ropes in order to prevent uncontrolled movement of the test sphere after the first rebound from the bed of the trampoline. The use of overhead spotting rigs has been found to be useful for this purpose.~~
6.1 *Test sphere:* The test sphere shall be a metal sphere with a diameter of 40 cm ± 1 cm and a mass of 60 kg ± 0.5 kg. To attach a magnetic fixation to the sphere, a flat plated upper section (up to a diameter of 10 cm) is acceptable.

6.2 *Recording equipment for the impact test* - The recording equipment shall meet the following criteria to measure the horizontal displacement at contact with the measuring plane: It is at the discretion of the test laboratory to select a specific instrumentation to monitor, record and determine the displacement of the sphere. The total system shall be capable of measuring coordinates with an accuracy of ± 3 cm. The requirements can be met by using an appropriate video or laser system with a minimum sample rate of 200Hz.

7 Equipment which has to be submitted for testing

7.1 The test specimen submitted for testing shall represent the HDMD with all hard- and software as it is intended to be used during training and/or competition for synchronized and individual exercises. The submission shall furthermore include the following parts:
7.2 Additional components for a calibration procedure, if necessary.
7.3 All additional accesories (e.g. adapter plates, etc) for the different designs of all certified trampolines at the time of the test (if required to avoid dysfunctions especially during vibrations or sliding of the trampoline's feet).
7.4 The test specimen shall comply with *TRA16 of FIG Apparatus Norms Part II*.
7.5 All components (soft- and hardware) shall be submitted with a full technical documentation written in English.
7.6 For the identification and documentation of the used software, the control sum (MD5) of the software version has to be desposited at the FIG Testing Institute.
7.7 If necessary, a specialized program version which allows data collection for single impacts during drop tests with the sphere has to be provided.

8 Conditioning and Test Temperature

Test specimens shall be preconditioned at 50% ± 10% relative humidity and 21° C ± 3° C for a minimum of 24 hours prior to the test. All testing shall be carried out under the same conditions.

9 Laboratory Procedure

9.1 *Impact locations:* A total of seven impact sites shall be designated on the trampoline. See Figure 1 for an illustration of the impact sites.

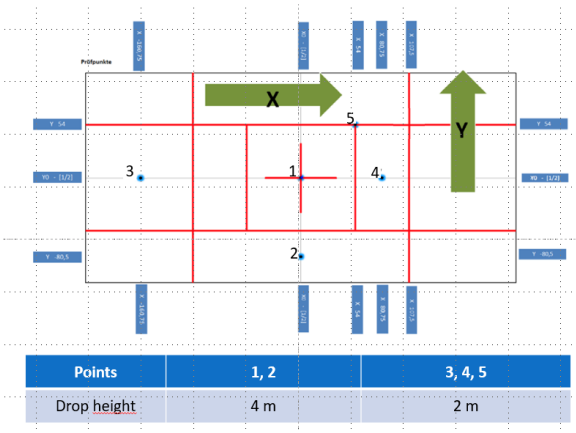


Figure 1: measurement points and drop heights for impact tests with a sphere on a trampoline's bed.

9.2 Install the test specimen with a certified trampoline on a smooth and solid floor and orient the impact test sphere so that the contact will be at one of the designated impact test sites.
9.3 Raise the test sphere to the designed drop height (400 cm +/- 2 cm for measurement points 1 and 2; 200cm +/- 2 cm for measurement points 3, 4 and 5) for the distance between the reference point of the test sphere and the unloaded bed of the trampoline

9.4 Release the test sphere and capture the horizontal displacement using recording equipment described in section 6.2.
9.5 Upon completion of a given impact test, raise the test sphere off the surface of the trampoline.
9.6 Check the displacement recordings of the HDMD and the data collection according 6.2 after every test. If there is any deviation during the free fall of the test sphere (i.e. by pulling at the overhead safety rigs too early or the test sphere did not hang absolutely still before release), the test shall be repeated.
9.7 Repeat the test procedures until five valid impacts at each of the five impact sites for a total of 25 impacts have been recorded.
9.8 Repeat the test procedures 9.1 to 9.7 if design differences (e.g. leg constructions) of the certified trampolines at the time of the test can influence the measurement of horizontal displacement (see section 4)
9.9 *Calculations*: For each impact test, calculate the distance between the position of the reference point of the test sphere at the first contact with the measuring plane and the reported result from the HDMD. Determine the maximal distance $maxd_{sphere}$ and the mean distance $meand_{sphere}$ in cm for all 25 measurements.

10 Report

The test report shall include the following information:
10.1 Complete identification of the tested HDMD, including type, source, manufacturer's model number (if available) and any other pertinent information. Photographs may be included in the test report for sample documentation purposes.
10.2 Test identification number according to the inter-

nal regulations between the FIG Test Institutes.
10.3 Complete identification of the testing laboratory including test technician and test laboratory manager (if available).
10.4 Conditions of test, including test date, temperature and humidity.
10.5 Description of the test results relative to the performance requirements identified in section 5.

This standard is subject to revision at any time by the FIG Apparatus Commission. You are invited to comment on revision of this standard or on additional standards. Comments should be addressed to the FIG General Secretary.

Standard Specification: 30 cm Landing Mats for DMT and TUM

This standard is issued under the fixed designation FIG: IV-TRA 17-01.05.2021; the numbers immediately following the designation indicate the date of original adoption by the FIG, or, in case of revision, the date of the last revision. This FIG standard was prepared by the Apparatus Commission of the FIG and participating FIG test laboratories. This standard was originally published in English only.

Introduction

The objective of this FIG standard is to provide equal opportunities for all athletes in FIG competitions by controlling the functional properties of landing mats and to minimize any differences between competition and training equipment.

1 Scope

1.1 This specification covers the measurement of certain shock-absorbing characteristics, the impact force - time relationships, and the rebound properties of 20 cm landing mats. This standard specification is applicable to all landing mat systems that are to be used at any FIG-sanctioned event.

1.2 This specification does not imply that an injury cannot be incurred while using a landing mat system which complies with this specification.

1.3 The test procedures associated with this standard may involve hazardous operations and equipment. This standard does not purport to address all the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to use.

2 Normative References

2.1 Society of Automotive Engineers: SAE J211 Recommended Practice for Instrumentation for Impact Tests – Requirements for Channel Class 1000, October 1988.

2.2 International Gymnastics Federation (FIG): Apparatus Rules: II-TRA 17.

3 Terminology

3.1 *Description of terms specific to this standard:*

3.1.1 *Acceleration:* The instantaneous time rate of change of velocity, expressed in m/s^2, which may be positive or negative.

3.1.2 *Base plane:* The starting reference plane of the landing mat system from which the total deflection and total height of rebound is determined. It is taken as the top plane of the landing mat system.

3.1.3 *Deflection:* The measured distance (in mm) between the base plane and the maximum displacement of the impactor below the base plane.

3.1.4 *Force (F):* The product of the mass of the impactor, expressed in kg, and the acceleration of the impactor, expressed in m/s^2.

3.1.5 *Maximum Force (F_{max}):* The maximum value of force measured during the impact and expressed in Newtons.

3.1.6 *Height of rebound:* The measured distance (in mm) between the base plane and the maximum displacement of the impactor above the base plane.

3.1.7 *Impactor:* The striking part of the test apparatus.

3.1.8 *Impact velocity:* The velocity of the impactor, expressed in m/s, immediately prior to crossing the base plane on impact.

3.1.9 *Theoretical drop height:* A calculated drop height which equates the measured velocity of the impactor at the moment of impact to a height that would generate the same velocity if the test were performed at sea level and there was no friction to retard the impactor during a drop from that height.

4 Principle of Measurement

4.1 A test specimen is impacted at a specified velocity with an impactor of given mass and geometry. A transducer mounted in the impactor monitors the acceleration – time history of the impactor which is recorded with the aid of a data acquisition system. An additional transducer may be used to monitor the displacement – time history of the impactor.

4.2 Dynamic data obtained during these procedures are indicative of the cushioning and rebound properties of the landing mat systems and materials used in training and FIG-sanctioned competitions.

5 Performance Requirements

5.1 When tested according to the procedures described in Section 9, the overall mean values of the measured variables across all impact sites shall be within the figures of Table 1.

5.2

Table 1: Figures for 30 cm Landing Mats

Deflection (mm)	***Height of rebound (mm)***	***F_{max} (N)***
≤ 165	≤ 90	≤ 3000

6 Test Apparatus

6.1 *Impact test machine:* Any type of dynamic testing apparatus that is capable of impacting a test specimen at a prescribed impact velocity and monitors and records the acceleration - time history of the impactor is acceptable. The impact test machine and the impactor shall have sufficient rigidity to eliminate undesirable vibrations in the apparatus which might be recorded on the acceleration - time curve. The impact test machine shall also be designed in such a

manner that only the impact face of the impactor contacts the test specimen at any time during the test procedures.

6.2 *Impactor:* The impactor shall be 20 kg ± 0.2 kg and shall have a flat impact face with a 10 cm ± 0.5 cm diameter. The edge of the impactor face should be relieved to eliminate sharp edges. Provision shall be made so that the accelerometer can be securely fastened parallel to the vertical axis of the impactor with a maximum deviation of ± 5º.

6.3 *Recording equipment - The recording equipment shall meet the following criteria:*

6.3.1 *Acceleration - time:* The selection of the specific acceleration - time recording equipment, including transducers and recorders, is at the discretion of the test laboratory. However, the recording system shall have a frequency response adequate to measure the peak acceleration value to an accuracy of ± 5% of the true value. The total system, detection and recording, shall be capable of measuring impact accelerations of up to 200 g at frequencies from 2 to 1000 Hz to an accuracy of ± 5%. The minimum sampling rate of the data acquisition system shall be 5000 Hz.

6.3.2 *Displacement - time:* It is optional, but desirable, that the displacement - time history is recorded by a separate transducer. Any transducer that provides a linear signal proportional to the displacement of the impactor along the impact axis which can be monitored simultaneously with the acceleration - time trace is acceptable. If displacement is recorded, the test equipment shall have means to determine and record the top plane (base plane) of the test specimen from which the total deformation and rebound height are determined.

6.3.3 *Filtering:* The signal from all transducers shall be conditioned with a low pass filter which complies with Channel Class 1000 of SAE Recommended Practice J211. A fourth-order Butterworth low pass filter with a cut-off frequency of 1000 Hz meets this requirement.

7 Test Specimen

7.1 The test specimen submitted for testing shall represent the landing mat as it is intended to be used during training and/or competition.

7.2 The test specimen shall comply with FIG Apparatus Rules: II-MAG11. Exception: See 7.3..

7.3 The minimum horizontal dimensions (length * width) for any test specimen shall be 200 cm * 120 cm.

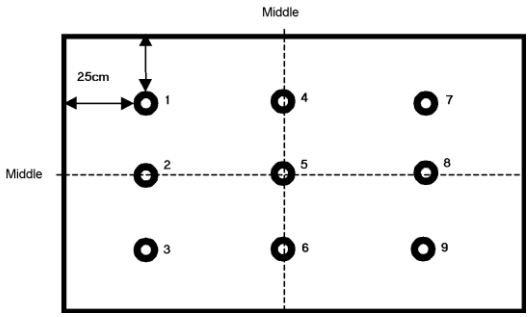
8 Conditioning and Test Temperature

8.1 Test specimens shall be preconditioned at 50% ± 10% relative humidity and 21° C ± 3° C for a minimum of 24 hours prior to the test. All testing shall be carried out under the same conditions.

9 Laboratory Procedure (Test Method)

9.1 *Impact locations:* A total of nine impact sites shall be designated on the test specimen. See Figure 1 for an illustration of the impact sites.

Figure 1: Impact Locations for Landing Mats



9.2 *Impact test procedures:*

9.2.1 Place the test specimen under the impact test machine on a smooth, solid floor (concrete or metal plate) and orient the impactor such that the centre of the impact face will contact one of the designated impact test sites.

9.2.2 Raise the impactor to an appropriate drop height such that it will contact the test specimen with an impact velocity of 3.96 m/s ± 3%. This corresponds to a theoretical drop height of 0.8 m.

9.2.3 Release the impactor and capture the acceleration - time history and displacement - time history (if applicable) using recording equipment described in Section 6.3.

9.2.4 Upon completion of a given impact test, raise the impactor off the surface of the test specimen.

9.2.5 The duration between tests at a given impact site shall not be less than 120 seconds.

9.2.6 Each test specimen shall receive a total of 90 impacts. Impact each of the nine impact sites ten times.

9.3 *Calculations:*

9.3.1 Immediately following each test, record the following measurements: F_{max} (N), Deflection (mm) and Height of rebound (mm).

9.3.2 The last eight tests for each impact site shall be used to determine the arithmetic mean value of a measured variable for each impact site and for the overall mean value of a measured variable across all impact sites.

9.3.3 Calculate the mean values of Deflection, Height of rebound and F_{max} across all impact sites rounded to zero decimal places.

10 Report

10.1 *The test report shall include the following information:*

10.1.1 Complete identification of the tested landing mat, including type, source, manufacturer's

model number (if appropriate), dimensions of test specimen, and any other pertinent information. Photographs may be included in the test report for sample documentation purposes.

10.1.2 Test identification number according to the internal regulations between the FIG Test Institutes.

10.1.3 Complete identification of the testing laboratory including test technician and test laboratory manager (if appropriate).

10.1.4 Conditions of test, including test date, temperature and humidity.

10.1.5 Description of the impactor mass and the drop height conditions.

10.1.6 Description of the test results relative to the performance requirements identified in Section 5.

10.1.7 Mean values of Deflection, Height of rebound and F_{max} across all impact sites.

10.1.8 Maximum value, minimum value and standard deviation of Deflection, Height of rebound and F_{max} variables.

10.1.9 Mean values of Deflection, Height of rebound and F_{max} for the last eight tests at each impact site.

10.1.10 Deflection, Height of rebound and F_{max} values for all tests.

This standard is subject to revision at any time by the FIG Apparatus Commission. You are invited to comment on revision of this standard or on additional standards. Comments should be addressed to the FIG General Secretary.

Apparatus Control TRA
(Intensive Control - Forms B)
(Forms A: see FIG Apparatus Norms Part III)

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Prior to every FIG Event in MAG, WAG, TRA and RG an apparatus control shall be scheduled before the first contact of athletes with the equipment. The completed forms have to be reported to the TC President or if he/she is not at the competitions site to the FIG Event Delegate and to the President of the FIG Apparatus Commission. According to the FIG event, different forms shall be used:

Form A: (FIG TC Delegate)
Competitions: World Cups, Continental Games (without FIG Apparatus Commissioner)

Main aspects for the apparatus control with form A:

- To be performed 1-2 h prior to the first contact of the athletes with the equipment.
- To be done for training hall (every set), warming up hall and competition hall.
- Control of specifications of the FIG Apparatus Manual.
- Judgment of non-described safety relevant aspects.
- Control of all adjustable heights, lengths etc. at the apparatuses.
- Control of all security relevant parts (fixings, stability and mats displacement).
- If necessary monitoring of apparatus relevant ad hoc decisions of the TP / TC or other FIG Authorities.

Remark: Forms A are published in FIG Apparatus Norms Part III.

Form(s) B: (FIG Apparatus Commissioner)
Competitions: World Championships and Olympic Games (with FIG Apparatus Commissioner)

Main aspects for the apparatus control with forms B:

(IC) Intensive Control (FIG Apparatus Commissioner):
- To be done for training hall (every set), warming up hall and competition hall
- To be performed prior to the first contact of the athletes with the equipment
- Control of accordance of equipment with the tested Specimen
- Control of all specifications of the FIG Apparatus Manual
- Judgment of non-described safety relevant aspects
- Report of the results to the Technical President
- If necessary, monitoring of apparatus relevant ad hoc decisions of the TP / TC or other FIG Authorities

(FC) Final Control (Technical Committee Member(s), FIG Apparatus Commissioner):
- To be performed immediately prior to the competition or the podium training.
- Control of all adjustable heights, lengths etc. at the apparatuses.
- Control of all security relevant parts (fixings, stability and mats displacement).

(LC) Daily Light Control (FIG Apparatus Commissioner):
- To be performed every day in all training and warming up halls.
- Control of accordance of the equipment with the time of the extensive control.
- Control of all adjustable heights, lengths etc. at the apparatuses.
- Control of all security relevant parts (fixings, stability and mats displacement).

Apparatus Control TRA
(Intensive Control - Forms B)
(Forms A: see FIG Apparatus Norms Part III)

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APPARATUS CONTROL B (IC) - TRAMPOLINE GYMNASTICS

Competition:

Discipline: **TRA**	Site: ***Training Hall***	Date:		
General intensive Control (FIG Apparatus Manager)				
TRA 1 Trampoline "Trampoline 1" **TRA 11 Safety mat 20 cm TRA 12 Spotter mat**	**Stipulation**	**Result - Action**		
Concordance with test report:				
Springs:				
Trampoline		***Measurements in cm***		
Width bed	***214 ± 5 cm / var < 3 cm***	bw1:	bw2:	bw3:
Length bed	***428 ± 6 cm / var < 3 cm***	bl1:	bl2:	bl3:
Width jumping zone	***108 ± 4 cm / var < 2 cm***	jw1:	jw2:	jw3:
Length jumping zone	***215 ± 4 cm / var < 2 cm***	jl1:	jl2:	jl3:
red cross width	***70 ± 3 cm***			
red cross length	***70 ± 3 cm***			
feet contact to the ground	***all four feet have firm contact***			
frame horizontal widthside	***0° ± 0,5°***			
frame horizontal lengthside	***0° ± 0,5°***			
Height	all of h1; h2; ***≥ 115,0 cm***	***h1:***	***h2:***	
	all of h3; h4: ***≥ 115,0 cm***	***h3:***	***h4:***	
	one of h1; h2; h3; h4: ***115,5 ± 0,5 cm***			
All springs attached?				
Springs homogenous?				
Stability?				
Stands below the Podium?		***no podium***		
Safety platforms / mats				
Attachment to trampoline				
Fixation of the mats				
Width safety mats	***300 ± 2,5 cm***			
Length safety mats (incl wedge)	***240 ± 2,5 cm***			
Thickness safety mats (bedside)	***7,5 ± 0.5 cm***			
Thickness safety mats (end)	***20 ± 2,0 cm***			
Spotter mats				
sliding covering				
the two long sides of the mat				
Width spotter mat	***200 - 50 cm***			
Length spotter mat	***150 - 50 cm***			
Thickness spotter matt	***15 - 5 cm***			

Apparatus Control TRA
(Intensive Control - Forms B)
(Forms A: see FIG Apparatus Norms Part III)

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TRA 1 Trampoline "Trampoline 2" **TRA 11 Safety mat 20 cm TRA** **12 Spotter mat**	**Stipulation**	**Result - Action**
Concordance with test report:		
Springs:		
Trampoline		***Measurements in cm***
Width bed	***214 ± 5 cm / var < 3 cm***	bw1: bw2: bw3:
Length bed	***428 ± 6 cm / var < 3 cm***	bl1: bl2: bl3:
Width jumping zone	***108 ± 4 cm / var < 2 cm***	jw1: jw2: jw3:
Length jumping zone	***215 ± 4 cm / var < 2 cm***	jl1: jl2: jl3:
red cross width	***70 ± 3 cm***	
red cross length	***70 ± 3 cm***	
feet contact to the ground	***all four feet have firm contact***	
frame horizontal widthside	***0° ±0,5°***	
frame horizontal lengthside	***0° ±0,5°***	
Height	all of h1; h2; ***≥ 115,0 cm***	***h1:*** ***h2:***
	all of h3; h4: ***≥ 115,0 cm***	***h3:*** ***h4:***
	one of h1; h2; h3; h4: ***115,5 ± 0,5 cm***	
All springs attached?		
Springs homogenous?		
Stability?		
Stands below the Podium?		***no podium***
Safety platforms / mats		
Attachment to trampoline		
Fixation of the mats		
Width safety mats	***300 ± 2,5 cm***	
Length safety mats (incl wedge)	***240 ± 2,5 cm***	
Thickness safety mats (bedside)	***7,5 ± 0.5 cm***	
Thickness safety mats (end)	***20 ± 2,0 cm***	
Spotter mats		
sliding covering		
the two long sides of the mat		
Width spotter mat	***200 - 50 cm***	
Length spotter mat	***150 - 50 cm***	
Thickness spotter matt	***15 - 5 cm***	
TRA 1 Trampoline "Trampoline 3" **TRA 11 Safety mat 20 cm TRA** **12 Spotter mat**	**Stipulation**	**Result - Action**
Concordance with test report:		
Springs:		
Trampoline		***Measurements in cm***
Width bed	***214 ± 5 cm / var < 3 cm***	bw1: bw2: bw3:
Length bed	***428 ± 6 cm / var < 3 cm***	bl1: bl2: bl3:
Width jumping zone	***108 ± 4 cm / var < 2 cm***	jw1: jw2: jw3:
Length jumping zone	***215 ± 4 cm / var < 2 cm***	jl1: jl2: jl3:
red cross width	***70 ± 3 cm***	
red cross length	***70 ± 3 cm***	
feet contact to the ground	***all four feet have firm contact***	
frame horizontal widthside	***0° ±0,5°***	
frame horizontal lengthside	***0° ±0,5°***	

Apparatus Control TRA
(Intensive Control - Forms B)
(Forms A: see FIG Apparatus Norms Part III)

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Height	all of h1; h2;	***≥ 115,0 cm***	***h1:***	***h2:***	
	all of h3; h4:	***≥ 115,0 cm***	***h3:***	***h4:***	
	one of h1; h2; h3; h4:	***115,5 ± 0,5 cm***			
All springs attached?					
Springs homogenous?					
Stability?					
Stands below the Podium?			***no podium***		
Safety platforms / mats					
Attachment to trampoline					
Fixation of the mats					
Width safety mats	***300 ± 2,5 cm***				
Length safety mats (incl wedge)	***240 ± 2,5 cm***				
Thickness safety mats (bedside)	***7,5 ± 0.5 cm***				
Thickness safety mats (end)	***20 ± 2,0 cm***				
Spotter mats					
sliding covering					
the two long sides of the mat					
Width spotter mat	***200 - 50 cm***				
Length spotter mat	***150 - 50 cm***				
Thickness spotter matt	***15 - 5 cm***				
TRA 1 Trampoline "Trampoline 4" **TRA 11 Safety mat 20 cm TRA 12 Spotter mat**	**Stipulation**		**Result - Action**		
Concordance with test report:					
Springs:					
Trampoline			***Measurements in cm***		
Width bed	***214 ± 5 cm / var < 3 cm***		bw1:	bw2:	bw3:
Length bed	***428 ± 6 cm / var < 3 cm***		bl1:	bl2:	bl3:
Width jumping zone	***108 ± 4 cm / var < 2 cm***		jw1:	jw2:	jw3:
Length jumping zone	***215 ± 4 cm / var < 2 cm***		jl1:	jl2:	jl3:
red cross width	***70 ± 3 cm***				
red cross length	***70 ± 3 cm***				
feet contact to the ground	***all four feet have firm contact***				
frame horizontal widthside	***0° ± 0,5°***				
frame horizontal lengthside	***0° ± 0,5°***				
Height	all of h1; h2;	***≥ 115,0 cm***	***h1:***	***h2:***	
	all of h3; h4:	***≥ 115,0 cm***	***h3:***	***h4:***	
	one of h1; h2; h3; h4:	***115,5 ± 0,5 cm***			
All springs attached?					
Springs homogenous?					
Stability?					
Stands below the Podium?			***no podium***		
Safety platforms / mats					
Attachment to trampoline					
Fixation of the mats					
Width safety mats	***300 ± 2,5 cm***				
Length safety mats (incl wedge)	***240 ± 2,5 cm***				
Thickness safety mats (bedside)	***7,5 ± 0.5 cm***				
Thickness safety mats (end)	***20 ± 2,0 cm***				

Apparatus Control TRA
(Intensive Control - Forms B)
(Forms A: see FIG Apparatus Norms Part III)

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Spotter mats			
sliding covering			
the two long sides of the mat			
Width spotter mat	***200 - 50 cm***	***169,1***	
Length spotter mat	***150 - 50 cm***	***119,4***	
Thickness spotter matt	***15 - 5 cm***		
TRA 2 Double Mini-Tramp	**Stipulation**	**Result - Action**	
Frame			
no fixation across the ends of DMT			
rounded edges			
Safety Padding			
Thickness	***max 0,55***		
no part of the bed is covered			
fixation to the frame			
distance between bed / padding	***max 6,0***		
frame ends (dismount side) covered	***min 0,5***		
Wedge			
Dimension	***30*30 Triangle***		
firmly fixed to landing mat	***no gap***		
Bed			
Width Bed (excl attachmet straps)	***92 ± 1,0***	***291,1***	
Length Bed (excl attachment straps)	***285 ± 5,0***	***283***	
Height (Mounting end)	***45 ± 10,0***		
Heigt (Dismounting end)	***70 ± 10,0***		
Width of web (under tension)	***min 0,4 ; max 1,3***		
Width of strings (under tesion)	***0,3 ± ,1***		
Distance between strands (web)	***max 1,8***		
Distance between strands (strings)	***max 1,0***		
Penalty zone			
End markers	***13 ± 2,0***		
Centre zone	***39 ± 1,0***		
Distance of the centre zone	***90 ± 2,0***		
Landing area			
Length of landing area	***600 ± 1,0***		
Width of landing area	***300 ± 1,0***		
Thickness	***30 ± 1,0***		
Connection wedge and Landing m.	***position below the bed of the DMT***		
Supplementary mat	***10 cm, firmly fixed, with landing zones***		
Landing zones			
Zone C	***see Landing area above***		
Zone B Length	***400 ± 1,0***		
Zone B Width	***200 ± 1,0***		
Zone A Length	***200 ± 1,0***		
Zone A Width	***100 ± 1,0***		
Distance DMT / Zone A	***70***		
Run up			
Length run up	***2500 +100***		
Width run up	***min 100***		
Thickness	***2,5 ± 0,5***		
Spotter mats			
sliding covering			

Apparatus Control TRA
(Intensive Control - Forms B)
(Forms A: see FIG Apparatus Norms Part III)

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two handles or one long handle on			
Width spotter mat	***200 - 50***		
Length spotter mat	***150 - 50***		
Thickness spotter matt	***15 - 5***		
safety mats at both sides of DMT			
Length	***300 ± 1,0***		
Width	***200 ± 1,0***		
Heigth	***20 ± 1,0***		
TRA 3 Tumbling Track "Tumbling	**Stipulation**	**Result - Action**	
Concordance with test report:			
Tumbling Track			
Length	***2500 + 100***		
Width	***200 ± 5,0***		
Height	***max 30***		
width centre line	***5,0***		
width side lines	***5,0***		
distance side lines	***150 ± 1,0***		
Landing Area			
Length	***600 ± 1,0***		
Width	***300 ± 1,0***		
Heigth	***30 ± 1,0***		
Landing Zone			
Width of lines	***5,0***		
Length of Zone	***400 ± 1,0***		
Width of Zone	***200 ± 1,0***		
Run up			
Length	***1000 + 100***	***1052,5***	
Width	***min 100***	***103,1***	
Matting on both sides	***area width min 100 cm, Thickness between***		
Supplementary mat (mandatory)	***with landing zones***		
Even, without gaps			
Attachment to landing mat			
Length	***400 ± 1,0***		
Width	***200 ± 1,0***		
Height	***10 ± 1,0***		
Vaulting board			
S Concordance with test report:			
H Concordance with test report:			

Apparatus Control TRA
(Intensive Control - Forms B)
(Forms A: see FIG Apparatus Norms Part III)

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TRA
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Apparatus Control TRA
(Intensive Control - Forms B)
(Forms A: see FIG Apparatus Norms Part III)

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TRA
01.01.2016
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Apparatus Control TRA
(Final Control - Forms B)
(Forms A: see FIG Apparatus Norms Part III)

APPARATUS CONTROL B (FC) - TRA GYMNASTICS

Competition:

Discipline: **TRA** Site: Date:

Final Control (FIG Apparatus Manager, TC Representatives, Delegate AC)

TRA 1 Trampoline "Trampoline 1" **TRA 11 Safety mat 20 cm TRA** **12 Spotter mat**	**Stipulation**	**Result - Action**	
Trampoline			
Height	***115,5 ± 0,5***		
Width jumping zone	***108 ± 4***	a: b: c:	
Length jumping zone	***215 ± 4***	a: b: c:	
All springs attached?			
Stability?			
Safety platforms / mats			
Attachment to trampoline			
Fixation of the mats			
Spotter mats			
sliding covering			
two handles or one long handle on the two long sides of the mat			
TRA 1 Trampoline "Trampoline 2" **TRA 11 Safety mat 20 cm TRA** **12 Spotter mat**	**Stipulation**	**Result - Action**	
Trampoline			
Height	***115,5 ± 0,5***		
Width jumping zone	***108 ± 4***	a: b: c:	
Length jumping zone	***215 ± 4***	a: b: c:	
All springs attached?			
Stability?			
Safety platforms / mats			
Attachment to trampoline			
Fixation of the mats			
Spotter mats			
sliding covering			
two handles or one long handle on the two long sides of the mat			
TRA 1 Trampoline "Trampoline 3" **TRA 11 Safety mat 20 cm TRA** **12 Spotter mat**	**Stipulation**	**Result - Action**	
Trampoline			
Height	***115,5 ± 0,5***		
Width jumping zone	***108 ± 4***	a: b: c:	
Length jumping zone	***215 ± 4***	a: b: c:	
All springs attached?			
Stability?			
Safety platforms / mats			
Attachment to trampoline			
Fixation of the mats			
Spotter mats			
sliding covering			
two handles or one long handle on the two long sides of the mat			

Apparatus Control TRA
(Final Control - Forms B)
(Forms A: see FIG Apparatus Norms Part III)

TRA 1 Trampoline "Trampoline 4" TRA 11 Safety mat 20 cm 12 Spotter mat	**TRA**	**Stipulation**	**Result - Action**	
Trampoline				
Height		***115,5 ± 0,5***		
Width jumping zone		***108 ± 4***	a: b: c:	
Length jumping zone		***215 ± 4***	a: b: c:	
All springs attached?				
Stability?				
Safety platforms / mats				
Attachment to trampoline				
Fixation of the mats				
Spotter mats				
sliding covering				
two handles or one long handle on the two long sides of the mat				

Signatures **Time & date**

Apparatus Control TRA
(Final Control - Forms B)

(Forms A: see FIG Apparatus Norms Part III)

Apparatus Control TRA
(Light Control - Forms B)
(Forms A: see FIG Apparatus Norms Part III)

APPARATUS CONTROL B (LC) - TRA GYMNASTICS

Competition:

Discipline: **TRA**	Site:	Date:

Light Control (FIG Apparatus Manager)

TRA 1 Trampoline "Trampoline 1" **TRA 11 Safety mat 20 cm** **TRA 12 Spotter mat**	**Stipulation**	**Result - Action**	
Trampoline			
All springs attached?			
Weak springs changed?			
Safety platforms / mats			
Attachement to trampoline			
Fixation of the mats			
Spotter mats			
TRA 1 Trampoline "Trampoline 2" **TRA 11 Safety mat 20 cm** **TRA 12 Spotter mat**	**Stipulation**	**Result - Action**	
Trampoline			
All springs attached?			
Weak springs changed?			
Safety platforms / mats			
Attachement to trampoline			
Fixation of the mats			
Spotter mats			
TRA 1 Trampoline "Trampoline 3" **TRA 11 Safety mat 20 cm** **TRA 12 Spotter mat**	**Stipulation**	**Result - Action**	
Trampoline			
All springs attached?			
Weak springs changed?			
Safety platforms / mats			
Attachement to trampoline			
Fixation of the mats			
Spotter mats			
TRA 1 Trampoline "Trampoline 4" **TRA 11 Safety mat 20 cm** **TRA 12 Spotter mat**	**Stipulation**	**Result - Action**	
Trampoline			
All springs attached?			
Weak springs changed?			
Safety platforms / mats			
Attachement to trampoline			
Fixation of the mats			
Spotter mats			

Signature **Time & date**

V1.1 - GYMLAB A(LC) 04.02.2016

Standard Specification: Floors for Acrobatics

The standard specifications for floors for acrobatics are the same as for men artistic gymnastics, therefore, this standard refers to the FIG standard IV-MAG1.

See:

IV
MAG 1
01.01.2016
1-4

Standard Specification: Floors for Sports Aerobics

This standard is issued under the fixed designation FIG: IV-AER1-1.01.2016; the numbers immediately following the designation indicate the date of original adoption the FIG or, in case of revision, the date of the last revision. This FIG standard was prepared by the Apparatus Commission of the FIG and participating FIG test laboratories. This standard was originally published in English only.

Introduction

The objective of this FIG standard is to provide equal opportunities for all athletes in FIG competitions by controlling the functional properties of sports aerobic floors and to minimize any differences between competition and training equipment.

1 Scope

1.1 This specification covers the measurement of certain elastic and shock absorbing characteristics as well as gloss of sports aerobic floors. This standard specification is applicable to all sports aerobic floors that are to be used at any FIG-sanctioned event.

1.2 This specification does not imply that an injury cannot be incurred while using a sports aerobic floor which complies with this specification.

1.3 The test procedures associated with this standard may involve hazardous operations and equipment. This standard does not purport to address all the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to use.

2 Normative References

2.1 Society of Automotive Engineers: SAE J211 Recommended Practice for Instrumentation for Impact Tests – Requirements for Channel Class 1000, October 1988.

2.2 ISO 2813

2.3 ASTM D 523

2.4 DIN 67530

2.5 International Gymnastics Federation (FIG): Apparatus Rules: II-AER1.

3 Terminology

3.1 *Description of terms specific to this standard:*

3.1.1 *Base plane:* The starting reference plane of the sports aerobic floor from which deflection is determined. It is taken as the upper surface of the floor loaded by the loading disk prior to any impact.

3.1.2 *Deflection (D):* The measured distance (in mm) between the base plane and the bottom surface of the loading disk during the impact.

3.1.3 *Maximum deflection (D_{max}):* The maximum value of deflection (in mm) measured during the impact.

3.1.4 *Force (F):* The force applied to the sports aerobic floor during the impact, expressed in Newtons.

3.1.5 *Energy of deflection (E):* The integration value or calculated area under the force-deflection curve expressed in Nm (Newton*meter). The domain of integration is from the rising point to the maximum point of deflection on the curve.

3.1.6 *Rebound deflection (D_r):* The maximum rebounding displacement (in mm) of the bottom surface of the loading disk, measured from the plane of maximum deflection.

3.1.7 *Rebound time:* The difference in time (in s) between the point of maximum deflection and the point of rebound deflection.

3.1.8 *Rebound velocity (V_r):* The quotient of rebound deflection and rebound time expressed in mm/s.

3.1.9 *Intensity of rebound (D_rV_r):* The product of rebound deflection and rebound velocity expressed in mm^2/s.

3.1.10 *Loading disk:* The part of the test apparatus which applies the specified load to the test specimen.

3.1.11 *Gloss unit (GU):* Unit without dimension representing the gloss of the wooden surface of a sports aerobic floor according to a standardized measurement using a reflectometer at an angle of illumination of 85°.

4 Principle of Measurement

4.1 *The complete test procedures include 2 parts:* Determination of shock absorption and determination of gloss at the surface.

4.1.1 *Test A - Determination of shock absorption:* A specimen sports aerobic floor is impacted by dropping an impactor from a predetermined height onto a set of rubber springs and a loading disk which are located on the top surface of the test specimen prior to the impact. Transducers mounted in the loading disk shall monitor the force – time history and displacement – time history of the loading disk. This data shall be recorded with the aid of a data acquisition system.

4.1.2 *Test B – Determination of gloss at the surface*: The surface of a specimen sports aeorobic floor is exposed to a light source at an angle of illumination of 85°. The reflected quantity of light is measured in gloss units using a standardized reflectometer.

4.2 Data obtained during these procedures are indicative of the elastic and shock absorbing properties and gloss of sports aerobic floors used in training and FIG-sanctioned competitions.

5 Performance Requirements

5.1 When tested according to the procedures described in Section 9, the values of the measured variables shall be within the figures of Table 1.

Table 1: Figures for elasticity and shock absorption of sports aerobic floors
See Figure 2 for an illustration of the impact sites.
x represents the mean values of the measured variables

	D_{max} (mm)	E (Nm)	D_r (mm)	D_rV_r (mm²/s)
Mean value across impact sites 1 to 9	3.5 ≤ x ≤12.0	2.5 ≤ x ≤ 9.5	3.0 ≤ x ≤ 15.0	300 ≤ x ≤ 3600
Difference between highest and lowest mean values on impact sites 1 to 9	≤ 5.0	≤ 3.0	≤ 5.0	≤ 2400

Test Apparatus

5.2 *Impact test machine:* Any type of dynamic testing apparatus that is capable of impacting a test specimen at a prescribed loading condition and monitoring and recording the force - time history and deflection - time history of the loading disk is acceptable. The impact test machine shall have sufficient rigidity to eliminate undesirable vibrations in the apparatus which might be recorded on the force - time curve and deflection - time curve. The impact test machine shall also be designed in such a manner that only the bottom surface of the loading disk contacts the test specimen at any time during the test procedures.

5.3 *Loading system - The loading system of the impact test machine shall meet the following requirements (see Figure 1):*

5.3.1 *Characteristics of the dynamic load:* The maximum dynamic force shall be 1300N ± 2 % when this loading system is applied to the testing anvil. The time from the onset of force application to the time of maximum force shall be 50 ms ± 2 ms.

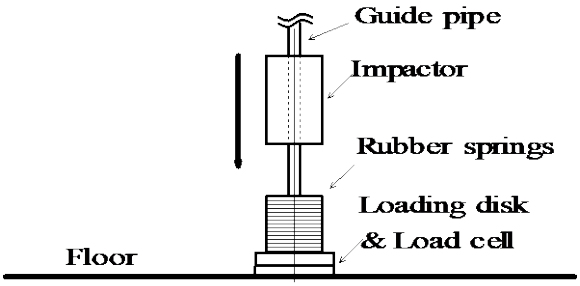
5.3.2 *Impactor:* The dropping impactor shall be 15 kg ± 0.1 kg and shall have a flat impact face. The impactor shall have the shape of a thick cylinder and shall be dropped along a guide pipe. The decision of the size of outside and inside diameters of the impactor is at the discretion of the test laboratory, but the clearance between the inside hole of the impactor and the guide pipe shall be 2 mm ± 0.2 mm. The dropping height of the impactor shall be 120 mm ± 1 mm to the upper surface of the rubber springs.

5.3.3 *Release mechanism:* The release mechanism shall be unattached to the loading disk and the guide pipe to prevent an additional load with the attached impactor on the loading disc and the test specimen before the impact.

5.3.4 *Loading disk and guide pipe:* The loading disk shall have a diameter of 70 mm ± 0.5 mm. The total mass of the loading disk including the force transducer and the guide pipe shall be 5 kg ± 0.2 kg.

5.3.5 *Rubber springs:* A set of rubber springs shall be selected so as to meet the requirements described in 6.2.1.

Figure 1: Setup of the loading system



5.4 *Recording equipment - The recording equipment shall meet the following criteria:*

5.4.1 *Force - time:* The selection of the specific force - time recording equipment, including transducers and recorders, is at the discretion of the test laboratory. However, the recording system shall have a frequency response adequate to measure the peak force value to an accuracy of ± 3% of the true value. The total system, detection and recording, shall be capable of measuring impact forces of up to 2000 N at frequencies from 2 to 1000 Hz to an accuracy of ± 3%. The minimum sampling rate of the data acquisition system shall be 5000 Hz.

5.4.2 *Displacement - time:* The selection of the specific displacement - time recording equipment, including transducers and recorders, is at the discretion of the test laboratory. However, the recording system shall have a frequency response adequate to measure the dynamic displacement value to an accuracy of ± 3% of the true value. The total system, detection and recording, shall be capable of measuring the displacement of ± 50 mm at frequencies from 2 to 1000 Hz to an accuracy of ± 3%. The minimum sampling rate of the data acquisition system shall be 5000 Hz.

5.4.3 *Filtering:* The signal from all transducers shall be conditioned with a low pass filter which complies with Channel Class 1000 of SAE Recommended Practice J211. A fourth-order Butterworth low pass filter with a cut-off frequency of 1000 Hz meets this requirement.

5.5 Gloss measurement device:

The used device shall be designed and built according to the standard ISO 2813 and ASTM D 523.

6 Test Specimen

6.1 The test specimen submitted for testing shall represent the sports aerobic floor as it is intended to be used during training and/or competition.

6.2 The test specimen shall comply with FIG Apparatus Rules: II-AER1. Exception: See 7.3.

6.3 The minimum horizontal dimensions (length * width) for any test specimen shall be 180 cm * 180 cm. The minimum dimensions shall be also larger than the dimensions of the basic module of the floor system.

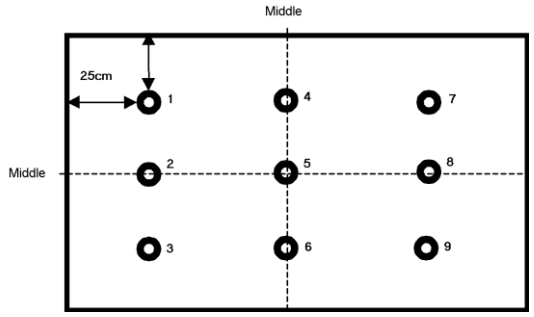
7 Conditioning and Test Temperature

7.1 The test specimen shall be preconditioned at 50% ± 10% relative humidity and 21° C ± 3° C for a minimum of 24 hours prior to the test. All testing shall be carried out under the same conditions.

8 Laboratory Procedure (Test Method)

8.1 *Impact sites:* A total of nine impact sites shall be designated on the test specimen. See Figure 2 for an illustration of the impact sites.

Figure 2: Impact sites on the sports aerobic floor



8.2 Impact test procedures:

8.2.1 Place the test specimen under the impact test machine on a smooth, solid and horizontal floor (concrete or metal plate) and orient the loading disk such that the centre of the loading disk contacts one of the designated impact test sites.

8.2.2 Raise the impactor to an appropriate drop height such that it will impact on the rubber springs and generate the proper dynamic load described in Section 6.2.

8.2.3 Release the impactor and capture the force - time history and displacement - time history using the recording equipment described in Section 6.3.

8.2.4 Upon completion of a given impact test, raise the impactor off the loading disk.

8.2.5 The duration between tests at a given impact site shall not be less than 120 seconds.

8.2.6 Impact each of the nine impact sites five times. Each test specimen shall receive a total of 45 impacts.

8.3 *Calculations:*

8.3.1 Immediately following each test, record the following measurements: D_{max} (mm), E (Nm), D_r (mm) and D_rV_r (mm^2/s).

8.3.2 Determine the arithmetic mean values of the measured variables for each impact site and for the overall mean values of the measured variables across all impact sites. Determine also the differences between the highest and lowest mean values of the measured variables for each test site and across all test sites.

8.3.3 Calculate the values of all required variables rounded to the decimal places of the corresponding figures identified in Section 5.

8.4 Gloss measurement procedure:

The measurement shall be taken at 6 sites. For the first three measurements the orientation of the gloss measuring device (see 5.5) is the same. For the last three measurements the device shall be rotated by 90° about the vertical axis of the device. The measurement sites are choosen randomly but shall have a minimum distance of 10cm to each other.

8.4.1 Calculations:

Immidiately follwing every test, record the result in Gloss Units (see 3.1.11).

Then determine the arithmetic mean value of all six measurements. Determine also the difference between the highest and lowest measurement.

9 Report

9.1 *The test report shall include the following information:*

9.1.1 Complete identification of the tested sports aerobic floor, including type, source, manufacturer's model number (if appropriate), dimensions of test specimen, and any other pertinent information. Photographs may be included in the test report for sample documentation purposes.

9.1.2 Test identification number according to the internal regulations between the FIG Test Institutes.

9.1.3 Complete identification of the testing laboratory including test technician and test laboratory manager (if appropriate).

9.1.4 Conditions of test, including test date, temperature and humidity.

9.1.5 Description of the impactor mass and the drop height conditions. A sample loading rate curve may be included in the test report to indicate compliance with the loading requirements of 6.2.1.

9.1.6 Description of all test results related to the performance requirements identified in Section 5.

9.1.7 *Supplemental description of the test results:*

9.1.7.1 Maximum value, minimum value and standard deviation of D_{max}, E, D_r and D_rV_r variables.

9.1.7.2 Mean values of D_{max}, E, D_r and D_rV_r variables at each impact site.

9.1.7.3 D_{max}, E, D_r and D_rV_r values for all tests.

Standard Specification: Obstacles and Scaffolding

For obstacles and scaffolding in Parkour, no tests exclusively prescribed for the testing institute are necessary. All specifications are contained in FIG Apparatus Norms Part II – PK.

Manufacturer must submit for the certification of obstacles and scaffoldings:

- Technical drawings with all norm-relevant dimensions
- A confirmation that all requirements of FIG Apparatus Norms Part II PK2/3 have been complied with (except for 4.6.2 slip resistance and 4.6.3 tilt resistance):

„We confirm that the Obstacle / Scaffolding ___ (insert name and/or product number) meets the requirements of FIG Apparatus Norms Part 2, PK 2 (obstacles) and/or PK 3 (scaffolding). Proof of this is attached in the form required by the standard. Excluded from this are explicitly points 4.6.2 slip resistance and 4.6.3 tilt resistance, as they depend on the respective installation situation."

For the approval of tracks and courses the supplier must submit before the first athlete touches the equipment to the competition management:

- Technical drawings with all norm-relevant dimensions
- A confirmation that all requirements of the standard have been complied with:

„We confirm that all tracks, obstacles and scaffoldings used at ___ (insert name and event ID) meet the requirements of FIG Apparatus Norms Part 2.7 Parkour and had been installed accordingly. Particular attention was paid during design and installation to compliance with the functional properties (point 4). Proof of this is attached in the form required by the standard."

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01.04.2026
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APPENDIX 1
FIG International Gymnastics Federation
Preliminary and provisional Standard Specification for InflatableTumbling Tracks
TRA – Trampoline

Guideline: Inflatable Tumbling Tracks

This guideline is issued under the fixed designation FIG: IV-TRA3b-01.04.2026; the numbers immediately following the designation indicate the date of original adoption by the FIG, or, in case of revision, the date of the last revision. This FIG guideline was prepared by the Apparatus Commission of the FIG and participating FIG test laboratory GYMLAB. This standard was originally published in English only.

Introduction

The FIG has decided to pursue a long-term strategy for the introduction of Inflatable Tumbling Tracks. The following timeline is planned (as of 2024):

Table 1: FIG Timeline for the introduction of Inflatable Tumbling Tracks

July 2024	EC approval for testing process
July to December 2024	First certifications
Cycle 2025 - 2028	Approved Inflatable tumbling track for development and acrobatic element learning. Fig promotion toward new and developing countries
	Survey of countries using this type of equipment at different level.
	Technical committee proposals for adapted rules
	Testing and approval of the links between run up and landing area with the Inflatable track
Cycle 2029 – 2032	Certify the Inflatable tumbling track for Cat 4 competition
Cycle 2033 - 2036	If all surveys prove good results, implement Inflatable tumbling track for any FIG competitions.

In the course of this process, as a result of increasing practical experience with such tracks, it is to be expected that several amendments to this standard will be adopted before a final introduction for FIG competitions.

With the same intention as for the standardised competition equipment of the FIG, it is emphasised that this standard does not cover any safety guarantees for risks arising from the use of the equipment. In particular, the danger of improper use and use with untrained personnel must be pointed out.

The objective of this FIG standard is to provide equal opportunities for athletes' acrobatic element learning and involved companies for the development of Inflatable Tumbling Tracks by controlling the functional properties and to minimize any differences between training equipment.

1 Scope

1.1 This specification covers the measurement of certain shock-absorbing characteristics, the impact force - time relationships, and the rebound characteristics of Inflatable Tumbling Tracks. This standard specification is applicable to all Inflatable Tumbling Tracks that are to be used at any FIG-sanctioned event.

1.2 This specification does not imply that an injury cannot be incurred while using an inflatable tumbling track which complies with this specification.

1.3 The test procedures associated with this specification may involve hazardous operations and equipment. This specification does not purport to address all the safety problems associated with its use. It is the responsibility of the user of this document to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to use.

2 Normative References

2.1 Society of Automotive Engineers: SAE J211 Recommended Practice for Instrumentation for Impact Tests – Requirements for Channel Class 1000, October 1988.

2.2 International Gymnastics Federation (FIG): Apparatus Rules: II-TRA3b.

3 Terminology

3.1 *Description of terms specific to this document:*

3.1.1 *Acceleration:* The instantaneous time rate of change of velocity, expressed in m/s^2, which may be positive or negative.

3.1.2 *Base plane:* The starting reference plane of the tumbling track from which Deflection and the total height of rebound is determined. It is taken as the top plane of the tumbling track.

3.1.3 *Performance area and Test specimen:* Complete construction of the inflatable tumbling track as intended to be used according to the specifications in FIG Apparatus Norms Part II, TRA3b.

3.1.4 *Deflection:* The measured distance (in mm) between the base plane and the maximum displacement of the impactor below the base plane.

3.1.5 *Force (F):* The product of the mass of the impactor, expressed in kg, and the acceleration of the impactor, expressed in m/s^2.

3.1.6 *Maximum Force (F_{max}):* The maximum value of force measured during the impact and expressed in Newtons.

3.1.7 *Height of rebound:* The calculated distance (in mm) between the base plane and the maximum vertical displacement of the impactor above the base plane under idealized frictionless conditions.

3.1.8 *Impactor:* The striking part of the test apparatus. An additional transducer may be used to monitor the displacement – time history of the impactor.

4 Principles of Measurement

4.1 A test specimen is impacted with an impactor of given mass and geometry from a specified drop height. A transducer mounted inside the

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FIG International Gymnastics Federation
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impactor monitors the acceleration – time history of the impactor which is recorded with the aid of a data acquisition system.

4.2 Dynamic data obtained during these procedures are indicative of the cushioning and rebound properties of Inflatable Tumbling Tracks used in training *(and in the future in FIG-sanctioned competitions)*.

5 Performance Requirements

5.1 When tested according to the procedures described in Section 9.1, the overall mean values of the measured variables across all impact sites shall be within the figures of Table 1.

Table 1: Figures for Inflatable Tumbling Tracks

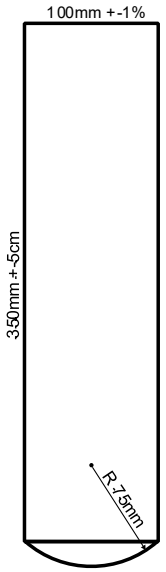
Deflection (mm)	*Height of Rebound (mm)*	F_{max} *(N)*
x ≥ 180	700 ≤ x ≤ 800	x ≤ 5800

6 Test Apparatus for Impact Tests

6.1 *Impact test machine:* Any type of dynamic testing apparatus that is capable of impacting a test specimen with an impactor from a prescribed drop height and monitoring and recording displacement – time and the acceleration - time history of the impactor is acceptable. The impact test machine shall be designed in such a manner that only the impact face contacts the test specimen at any time during the test procedures. It is optional, but desirable, that the impactor is released from a magnet.

6.1.1 *Impactor:* The impactor shall consist of a cylindrical test body with a mass of 30 kg ± 0.3 kg and a geometry as specified in Figure 1. The accelerometer shall be rigidly mounted on the impactor near to the longitudinal axes of the impactor.

Figure 1: Geometry of Impactor



6.1.2 *Recording equipment* - The recording equipment shall meet the following criteria:

6.1.2.1 *Acceleration - time:* The selection of the specific acceleration - time recording equipment, including transducer and recorder, is at the discretion of the test laboratory. However, the recording system shall have a frequency response adequate to measure the peak acceleration value to an accuracy of ± 5% of the true value. The total system, detection and recording, shall be capable of measuring impact accelerations of up to 100 g at frequencies from 2 to 1000 Hz to an accuracy of ± 5%. The minimum sampling rate of the data acquisition system shall be 5000 Hz.

6.1.3 *Displacement - time:* It is optional, but desirable, that the displacement - time history is recorded by a separate transducer. Any transducer that provides a linear signal proportional to the displacement of the impactor along the impact axis which can be monitored simultaneously with the acceleration - time trace is acceptable. If displacement is recorded, the test equipment shall have means to determine and record the top plane (base plane) of the test specimen from which the total deformation and rebound height are determined.

6.1.3.1 *Filtering:* The signal from the transducer shall be conditioned with a low pass filter which complies with Channel Class 1000 of SAE Recommended Practice J211. A fourth-order Butterworth low pass filter with a cut-off frequency of 1000 Hz meets this requirement.

7 Test Specimen

7.1 The test specimen submitted for testing shall be a complete tumbling track as it is intended to be used during training *(and/or competition)*.

7.2 The test specimen shall comply with FIG Appa-

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Preliminary and provisional Standard Specification for InflatableTumbling Tracks
TRA – Trampoline

ratus Rules: II-TRA3b.

8 Conditioning and Test Temperature

8.1 The test specimen shall be preconditioned at 50% ± 10% relative humidity and 21° C ± 3° C for a minimum of 24 hours prior to the test. All testing shall be carried out under the same conditions.

9 Laboratory Procedure (Test Method)

9.1 *Impact locations:* A total of eight impact sites shall be designated on the test specimen. See Figure 2 for an illustration of the impact sites.

9.2 Impact test procedures:

9.2.1 Place the test specimen under the impact test machine on a smooth, solid floor (concrete or metal plate) and orient the impactor such that the centre of the impact face will contact one of the designated impact test sites.

9.2.2 Raise the impactor to the drop height of 1.20 m ± 3mm.

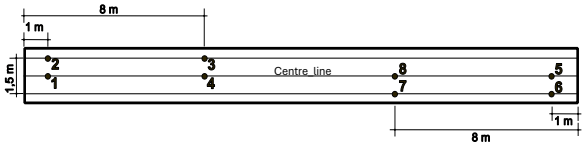
9.2.3 Release the impactor and capture the displacement and acceleration - time history using recording equipment described in Section 6.

9.2.4 Upon completion of a given impact test, raise the impactor off the surface of the test specimen.

9.2.5 The duration between tests at a given impact site shall not be less than 30 seconds.

9.2.6 Each test specimen shall receive a total of 80 impacts. Impact each of the eight impact sites ten times.

Figure 2: Impact Locations for Inflatable Tumbling Tracks



9.3 Calculations:

9.3.1 Immediately following each test, calculate and record the following measurements: Deflection (mm); Height of rebound (mm) and F_{max} (N).

9.3.2 The last eight tests for each impact site shall be used to determine the arithmetic mean value of a measured variable for each impact site and for the overall mean value of a measured variable across all impact sites.

9.3.3 Calculate the mean values of Deflection, Height of rebound and F_{max} across all impact sites rounded to zero decimal places.

10 Report

10.1 *The test report shall include the following information:*

10.1.1 Complete identification of the tested tumbling track, including type, source, manufacturer's model number (if appropriate), dimensions of test specimen, and any other pertinent information. Photographs may be included in the test report for sample documentation purposes.

10.1.2 Test identification number according to the internal regulations between the FIG Test Institutes.

10.1.3 Complete identification of the testing laboratory including test technician and test laboratory manager (if appropriate).

10.1.4 Conditions of test, including test date, temperature and humidity.

10.1.5 *Impact Test*:

10.1.5.1 Description of the impactor mass, the drop height conditions and the pressure in psi of the Inflatable Tumbling Track during the impacts.

10.1.5.2 Description of the test results relative to the performance requirements identified in Section 5.1.

10.1.5.3 Mean values of Deflection, Height of Rebound and F_{max} across all impact sites.

10.1.5.4 Maximum value, minimum value and standard deviation of Deflection, Height of Rebound and F_{max} variables.

10.1.5.5 Mean values of Deflection, Height of Rebound and F_{max} for the last eight tests at each impact site

10.1.5.6 Deflection, Height of rebound and F_{max} for all tests.