



Report No: 36384/1:IRO:SMH

TEST REPORT

DATE ISSUED: 21 December 1993

ITEM TESTED: **FOLDING CHAIR**

CLIENT'S NAME: Metal Spray Engineering Ltd
PO Box 110
DUNEDIN

Attention: Mr Mike Goatley

CLIENT'S REFERENCE: -

TEST SPECIFICATION: See Methods, below.

DATE OF TEST COMPLETION: 17 December 1993

SUMMARY OF RESULTS: See body of report.

This Report Must Not Be Quoted Except In Full



ALL TESTS REPORTED HEREIN
HAVE BEEN PERFORMED IN
ACCORDANCE WITH THE
LABORATORY'S TERMS
OF REGISTRATION

LABORATORY REGISTRATION
NUMBER: 1339

Prepared By: IR Orchard

Checked By: JV Hall

TELARC Approved
Signatory: JV Hall

Please note that the terms of the TELARC registration
apply only to the measurements made.

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1. ITEM DESCRIPTION

A folding chair comprising two hinged tubular aluminium frames with moulded plastic seat and back rest. The two frames are riveted together. The sample tested was identified as having had the frame rivet holes punched after heat treatment.

2. TEST METHOD

The test was based on JIS S1032-1978. "Office Furniture:Steel Chairs", Clause 8.1.

2.1 Load Test

A 55 kg mass was secured to the chair. The rear leg bar was fixed to the floor with wooden pivots, plus a side brace to prevent lateral movement.

The front leg bar was raised 50 mm above the floor and allowed to drop. This operation was repeated 4000 times at a rate of 25 drops per minute. The chair was then inspected for distortion or damage.

Equipment used:

Platform scales IRL CI 451
Stopwatch DSE Y1051
Metal Rule IRL C1650

3. RESULTS

No permanent distortion or damage noted. Abrasion to contact points only.



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DATE ISSUED: 15 December 1993

ITEM TESTED: **FOLDING CHAIR**

CLIENT'S NAME: Metal Spray Engineering Ltd
PO Box 110
DUNEDIN
Attention: Mr Mike Goatley

CLIENT'S REFERENCE: -

TEST SPECIFICATION: See methods, below.

DATE OF TEST COMPLETION: 7 December 1993

SUMMARY OF RESULTS: See body of report.

THIS REPORT MUST NOT BE QUOTED EXCEPT IN FULL



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LABORATORY'S TERMS
OF REGISTRATION

LABORATORY REGISTRATION
NUMBER: 139

PREPARED BY: IR ORCHARD

CHECKED BY: JV HALL

TELARC APPROVED
SIGNATORY: JV HALL

PLEASE NOTE THAT THE TERMS OF TELARC REGISTRATION APPLY ONLY TO THE LOAD APPLIED

1. ITEM DESCRIPTION

A folding chair comprising two hinged tubular aluminium frames with moulded plastic seat and back rest. The two frames are riveted together.

Sample 1 was identified by the manufacturer as having heat treatment of the aluminium after the rivet holes had been punched. Samples 2 & 3 had the heat treatment before the rivet holes were formed.

2. TEST METHOD

Tests were based on ISO/BS 4875:Part 1:1985 Clause 7.1.1 & 7.1.2.

2.1 Maximum loading test

The chair was placed on the Force frame with a 250 x 250 x 50mm rubber pad covered with a 250 x 200 x 50mm wooden block on the seat. A vertical downward force was applied to the padding centred above the rivet connections until the chair collapsed.

Note was taken of the maximum force applied.

2.2 Seat static load test

Based on ISO/BS 4875:Part 1:1985 Clause 7.1.1 Test 1a.

The chair seat was loaded with a force of 2000N applied through the padding, centred above the frame rivets. The loading was repeated for a total of 10 cycles.

The chair was inspected for any permanent deformation or damage.

2.3 Back static load test

Based on ISO/BS 4875:Part 1:1985 Clause 7.1.2 Test 1b

The front aluminium frame 'foot' was secured to the force frame and a 2000N force applied through the padding, centred above the frame rivets. Concurrently, a 760N force was applied horizontally backward to the back of the chair. The application of these forces was repeated for a total of 10 cycles.

The chair was inspected for any permanent deformation or damage.

* The above forces are comparable to those required by the Standard for
* Test level 5 chairs, intended for Severe Contract use and/or use in termini,

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student common rooms or military barracks

The following instruments were used:

Force frame, IRL 1966

Load cell Kyowa IRL 1246

Load cell Bong Shin

MG P-3500 Strain indicator, IRL 10887

MG 3600 Peak hold indicator, IRL 2276

Vishnay Strain indicator, IRL 2087

3. RESULTS

3.1 Maximum loading test

Sample 1 Pre heat treated, maximum loading 2300N
Collapse had initiated on the back leg, just below the rivet.

Sample 2 Post heat treated, maximum loading 2500N
Collapse had initiated on the front leg, just below the rivet.

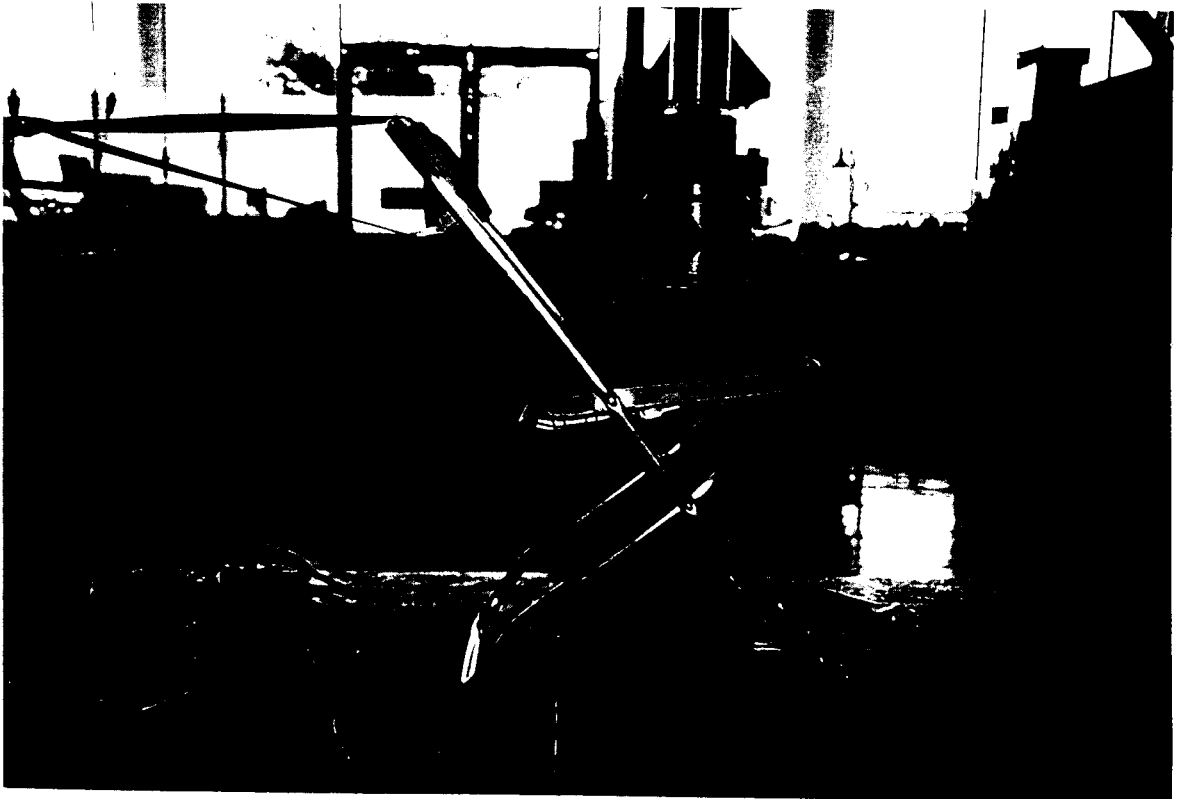
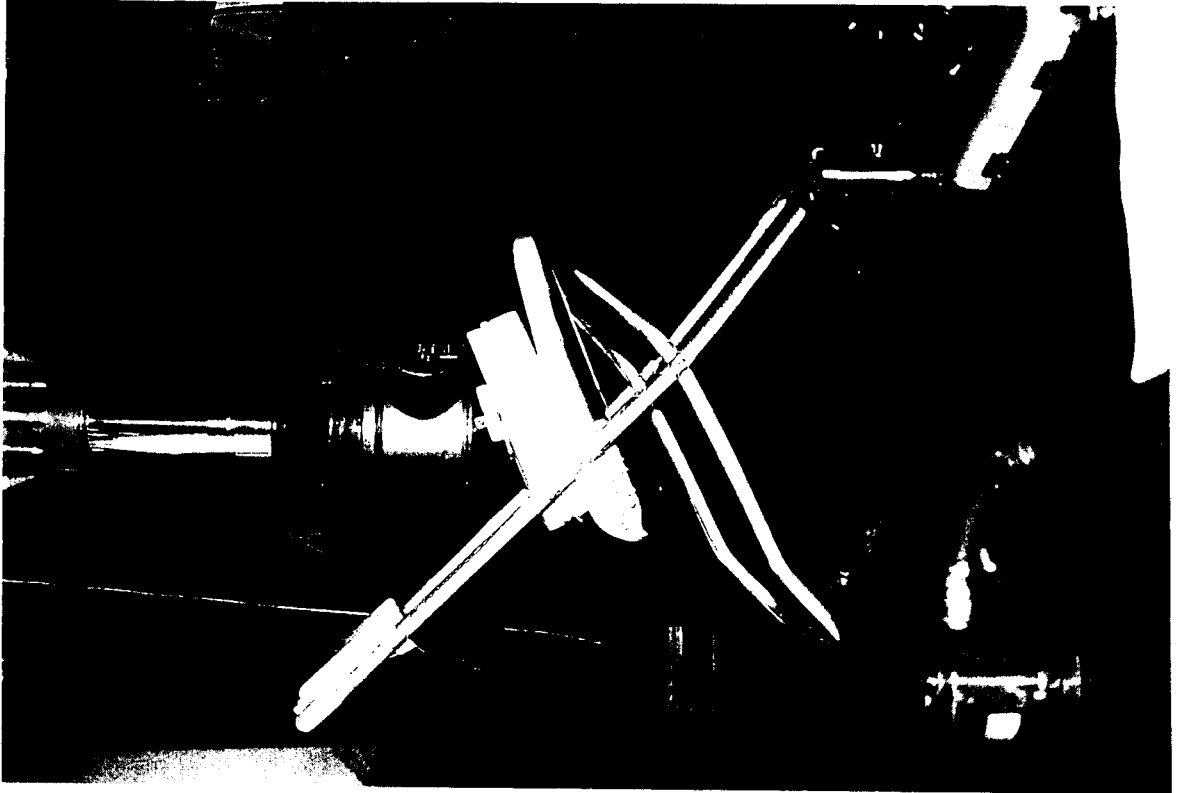
3.2 Seat static load Test Sample 3, no deformity or permanent damage noted.

3.3 Back static load Test Sample 3, very slight deformity of the left front leg around the rivet was noted.

It is estimated that the uncertainty associated with the above results does not exceed $\pm 5\%$.

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PHOTOGRAPHS



Appendix

Appendix A. Explanation of furniture test levels

Table 3 gives the type of use that might be expected from each furniture test level.

Test level	Description of performance		Example
1	Delicate		Obviously fine chairs
2	Careful domestic		Domestic bedroom
3	General domestic	Careful contract	Domestic living/dining room or hotel bedroom
4	Severe domestic	General contract	Seating where rough treatment and careless handling occur, e.g. college study, hotel reception
5		Severe contract	Seating intended for exceptionally severe use, e.g. termini, student common room and barrack room

Examples of the use of furniture for specific applications are given in BS 6250, and for information purposes are reproduced in table 4.

Type of use	Strength of frame (test level)				
	1	2	3	4	5
Folding garden and camping		x	x		
Domestic	x	x	x	x	
Office			x	x	x
Educational				x	x
Institutional					x
Hotel			x	x	
Non-specialized hospital			x	x	x
Military					x
Bar				x	x
Church			x		
Police station				x	x
Recreation room					x
Common room					x
Public hall				x	x

Methods

1. Scope

This Part of BS 4875 describes methods for determination of the strength of the structure of chairs and stools.

NOTE 1. Pouffes are considered to be stools.

NOTE 2. Tests carried out according to the requirements of this standard are intended to demonstrate the ability of the item to give satisfactory service in its intended environment. It should be understood that such tests do not ensure that structural failure will not eventually occur as a result of habitual mis-use or after an excessively long period of service.

NOTE 3. The tests are not suitable for demonstrating the structural strength of reclining and tilting chairs when in the reclined or tilted position.

NOTE 4. The titles of the publications referred to in this standard are listed on the inside back cover.

2 Principle

2.1 General

The principle is to determine the strength of the structure of an article of furniture by applying to various parts loads or forces simulating normal functional use, as well as acceptable mis-use, according to a graded scale of severity (see appendix A).

The interrelation of the tests is shown in table 1 and a summary is given in table 2.

The sequence as a whole determines the following:

- (a) static strength and initial damage;
- (b) fatigue strength and damage propagation;
- (c) ability to withstand acceptable mis-use and demonstration of sufficient residual strength.

The severity of loading is graded by varying the number of applications or the magnitude of forces applied.

2.2 Static tests

The principle of static tests is to assess the static strength of the article under the high levels of loading that only occasionally occur.

2.3 Fatigue tests

The principle of fatigue tests is to assess the strength of the component parts of the article under the repeated operations, movement, or applications of loads occurring during daily use.

2.4 Impact tests

The principle of impact tests is to assess the impact strength of the article under the rapid rates of loading that only occasionally occur.

Table 1. Test data (purpose of each test)

Sequence	Number	Title	Primary purpose	Secondary purpose	Type
1	1a 1b	Seat static load test Back static load test	Basic strength	Damage initiation	Functional
2	2	Arm and wing sideways static load test			
3	3	Arm downwards static load test			
4	4a 4b	Seat fatigue test Back fatigue test	Service durability	Damage propagation	
5	5a 5b 5c	Leg forwards and sideways test Static load test Diagonal base test	Handling strength	Residual strength	Acceptable mis-use
6	6	Seat impact test	Impact strength		
7	7a 7b	Back impact test Arm impact test			
8	8	Drop test			
9	9	Chair swivelling wear test	Service wear	No secondary purpose	Functional
10	10	Seat height adjustment wear test			

Table 2. Summary of test procedures

Number	Title	Description	Test level (see appendix A)				
			1	2	3	4	5
1a	Seat static load test	Seat force (in N)	—	1 100	1 300	1 600	2 000
1b	Back static load test	Back force (in N) at each pad	—	410	560	760	760
		Balancing seat force (in N)	—	1 100	1 300	1 600	2 000
2	Arm sideways static load test	Force applied (in N)	—	300	400	600	900
	Wing sideways static load test	Force applied (in N)	—	200	300	400	500
3	Arm downwards static load test	Force applied (in N)	—	700	800	900	1 000
4a	Seat fatigue test	Number of cycles: 950 N seat force	12 500	25 000	50 000	100 000	200 000
4b	Back fatigue test	Number of cycles: 330 N back force	12 500	25 000	50 000	100 000	200 000
5a	Leg forwards static load test	Maximum forward force (in N)	300	375	500	620	760
5b	Leg sideways static load test	Maximum sideways force (in N)	250	300	390	490	760
5c	Diagonal base force test	Balancing seat force (in N)	760	780	1 000	1 250	1 800
6	Seat impact test	Force applied (in N)	125	250	375	500	620
7a	Back impact test and	Drop height (in mm)	—	140	180	240	300
7b	Arm impact test	Drop height (in mm)	—	120	210	330	620
7a	Wing impact test	Angle (in degrees)	—	28	38	48	68
8	Drop test	Drop height (in mm)	—	120	210	330	620
		Angle (in degrees)	—	28	38	48	68
		Drop height (in mm)	150	300	450	600	900
		(a) Stacking chairs and stools with legs or pedestals longer than 200 mm,					
		(b) Non-stacking chairs with legs or pedestals longer than 200 mm,	—	150	200	300	450
		(c) Chairs and stools with legs or pedestals shorter than 200 mm	—	75	100	150	250
9	Chair swivelling wear test	Number of cycles	—	25 000	50 000	100 000	200 000
10	Seat height adjustment wear test	Number of cycles	—	—	10 000	15 000	25 000

NOTE. The absence of a value for certain tests at some test levels indicates that the test is not appropriate at that level.

3. General requirements for tests

3.1 Test loading

All loads and forces shall be measured to an accuracy of $\pm 5\%$.

NOTE. The tests may in certain cases be carried out by means of loads or forces. For practical purposes, a force of 10 N may be taken to be equal to the downward force due to a mass of 1 kg.

The apparatus used to apply seat loading shall not restrain the article from overturning, nor hinder horizontal movement of the article when the back force is applied.

3.2 Moisture content and conditioning

Before the tests are commenced the article shall be sufficiently old to ensure that all component materials have developed their full strength. At least 4 weeks in normal conditions shall elapse from manufacture in the case of glued joints in timber, plastics moulded parts, etc.

Parts made of timber products shall be checked with an electric moisture meter to ensure that the moisture content is between 8% and 12%. If the moisture content is too high the article shall be allowed to dry out in a warm ventilated room until the moisture content is between 8% and 12%.

If a standard atmosphere is required for conditioning or testing, that atmosphere shall be a temperature of $23 \pm 3^\circ\text{C}$ and a relative humidity of $50 \pm 5\%$.

3.3 Emergency tests

When there is not time for furniture to be aged or to reach equilibrium the moisture content shall be measured where applicable at the beginning and at the end of the testing sequence, and these measurements shall be included in the report if they are outside the limits specified, together with the age of the article when testing commenced.

3.4 Rate of carrying out the tests

The forces shall be applied at a sufficiently slow rate to ensure that negligible dynamic load is applied and also to ensure that kinetic heating does not occur.

During the static load tests described in 7.1 to 7.3 the forces shall be maintained for at least 10 s during each cycle.

NOTE. It is recommended that the tests are carried out at a maximum rate of six cycles per minute.

3.5 Setting-up of furniture

The articles shall be tested as delivered. Self-assembly furniture shall be assembled according to instructions supplied with the article. If the article can be combined in different ways the most adverse combination shall be used for each test.

4 Inspection before and after testing

Immediately before commencement of testing, each article shall be thoroughly inspected. Any defects in the members, joints or attachments shall be noted so that they are not attributed to the effect of the tests when the tests have been completed. A complete dimensional check shall be carried out on all articles that may suffer permanent deformation as a result of testing.

Immediately after completion of the tests, the article shall again be thoroughly inspected. Any apparent defects shall be noted and a determination made of any changes that have taken place since the initial inspection.

Fittings in self-assembly furniture shall be tightened before testing, and after each test level if testing is carried out at more than one test level.

NOTE 1. Fittings in self-assembly furniture that come loose during the tests do not constitute a test failure. Manufacturers of self-assembly furniture should be recommended to issue instructions with the furniture that fittings should be tightened occasionally.

Each article shall be subjected to each of the tests at the same test level in the order specified and the occurrence of any of the following shall be recorded as defects affecting the strength of the article:

- (a) any fracture of any member, joint or component, including seat suspensions and castors;
- (b) any fracture or cracking through the thickness of any part of a structural shell;
- (c) any loosening, shown to be permanent by hand pressure applied to suitable members, of joints intended to be rigid;
- (d) any loosening of the underframe or base inserts moulded into a structural shell relative to the shell surface, shown to be permanent by means of hand pressure applied to the underframe or base;
- (e) any free movement in the back, arms, legs or other components of the article greater than that noted in the initial inspection;
- (f) any deformation of any part of the article or any cracks that will adversely affect its appearance or strength;
- (g) any impairment of the operation of any mechanical part (including any significant change in the seat height during any phase of the seat height adjustment tests);
- (h) any clearly audible noise developed during testing.

NOTE 2. The test results are valid only for the article tested. When the test results are intended to be applied to other similar articles, the test specimen should be representative of the production model. Information on the scale of sampling to be employed can be obtained from BS 6001.

5 Apparatus

NOTE. For details of the sources of suitable test equipment write to Enquiry Section (London), BSI, 2 Park Street, London W1A 2BS, enclosing a stamped addressed envelope for reply.

5.1 Means of applying required loads or forces.

5.2 Means of measuring dimensions to an accuracy of ± 0.2 mm.

5.3 Loading point template, (see figures 1, 2 and 3) consisting of two shaped members fastened together by a pivot at one end. The contours of the shaped surfaces are so devised as to sink into the upholstery for a representative distance under moderate loads. For this purpose the seat loading arm shall have a total mass of 20 kg, applied through the seat loading point. The apparatus is marked as shown in figure 1 so that the template can be positioned easily with the two members at an angle of 90° to each other.

5.4 Stops, to prevent the article from sliding but not from overturning. Stops shall be not higher than 12 mm, except in cases where the design of the article necessitates the use of higher stops, where the lowest stop which will prevent the article from moving shall be used.

5.5 Seat loading pad*, a naturalistically shaped indenter as illustrated in figure 4, consisting of a rigid shaped surface.
NOTE. The shape, being complex, is defined not in a drawing but in existing moulds.

5.6 Smaller seat loading pad*, a rigid circular object 200 mm in diameter having a face with a convex spherical curvature of 300 mm radius and a 12 mm front edge radius (see figure 5).

5.7 Back loading pad*, a rigid rectangular object 200 mm high and 250 mm wide having a face curved across the width of the pad with a convex cylindrical curvature of 450 mm radius and with a 12 mm radius on all front edges (see figure 6).

5.8 Foam for facing pads, the seat and back loading pads (5.5, 5.6 and 5.7) are faced with a 25 mm thick layer of polyether foam with a hardness index, when measured in accordance with BS 4443 : Part 2, of 135/660 N at a density of 27 kg/m^3 to 30 kg/m^3 . Alternatively a layer of the polyether foam described above may be positioned between the loading pad and the test structure.

5.9 Local loading pad*, a rigid cylindrical object 100 mm in diameter having a flat face with a 12 mm radius on the front edge.

5.10 Impactor, a mass that is free to move in relation to the rest of the assembly, approximately 200 mm in diameter, separated from the striking surface by means of springs. The moving parts, less the springs, have a mass of not less than 17 kg, and the whole apparatus has a mass of 25 ± 0.1 kg. The springs are 400 ± 5 mm long with a closed

length of 124 ± 5 mm, a spring rate of 0.69 ± 0.1 kg/mm and are set to a working length of 253 ± 0.5 mm (see figure 7). The striking surface is an approximately flat leather pad containing fine dry sand.

5.11 Impact hammer, a striker in the form of a cylinder having a mass of 6.5 kg, supported from a pivot by a steel tube 38 mm in diameter with a wall thickness of 1.6 mm and having a mass of 2.00 ± 0.02 kg. The distance between the pivot and the centre of gravity of the striker is 1 m. The pendulum arm is pivoted by a low friction bearing (see figure 8).

5.12 Floor, comprising a rubber mat 2 mm thick having a hardness of 97 IRHD when measured in accordance with BS 903 : Part A26, resting on a concrete floor.

NOTE. This floor is specified only for the drop test (7.8).

6 Determination of seat and back loading points

6.1 Chairs

Position the template (5.3) with its load applied at the seat loading point on the centreline of the chair as far towards the rear as possible. Adjust its position by pushing the back loading portion into the back, so levering the seat portion forward until the shape of the template correlates with that of the chair (see figure 2). Mark the required loading points from the template.

6.2 Stools

Set up the template (5.3) at an angle of 90° with the aid of the mark as shown in figure 3. Place the template on the stool as shown in figure 2. Mark the required loading point from the template.

7 Procedures

7.1 Test 1: seat and back static load tests

7.1.1 Test 1a: seat static load test. Mount the seat loading pad (5.5) to conform to the seat plane, first at the seat loading point (see clause 6), and subsequently 100 mm back from the front edge of the seat. Apply the appropriate downward force, V_s , (see figure 9) specified in table 2 for a total of 10 times.

In cases such as pedestal and cantilever chairs, when it is not clear which of several positions of the seat loading pad is likely to cause failure, subject each of the positions to 10 applications of the force specified above, using, if appropriate, the smaller seat loading pad (5.6).

For stools, apply the force along the fore and aft centreline of the seat at the seat loading point (see clause 6).

*All loading pads should be capable of pivoting at least in the vertical plane and if design constrictions allow it, also in the horizontal plane.

Apply the force at the specified distance from any point on the circumference using, if necessary, the smaller seat loading pad (5.6).

Additionally for reclining chairs with footrests, repeat the test at the same test level on the footrest using the smaller seat loading pad (5.6), with the force applied at the centre of the footrest.

If required repeat the test on footrails or footrests at the appropriate test level.

NOTE. No force is specified for test level 1 since the required seat fatigue force (see 7.4.1) is 950 N.

7.1.2 Test 1b: back static load test with flexibility assessment. Position the centre of the back loading pad (5.7) either at the back loading point (see clause 6), or at 100 mm below the top of the back, whichever is the lower. Prevent the chair from rearwards movement by placing stops behind the rear feet or castors.

Apply the appropriate test force, H_s , specified in table 2 (see figure 10), perpendicular to the back when under load, a total of 10 times with the balancing seat force specified in table 2 applied at the seat loading point (see clause 6).

If the article tends to overturn reduce the back force to a magnitude that just prevents rearwards overturning. Report the actual force used (see (f)(1) of clause 9).

When this test is applied to an article fitted with a spring rocking action base that has a tension adjustment, increase the tension so that the least possible rocking movement is obtained during the test.

If it is not possible to apply the back force at the back loading point due to the construction of the article, e.g. if the back is constructed of cross-members positioned above and/or below the back loading point, use a suitable panel to spread the load over the back cross-members, ensuring that the panel used does not overlap the side upright members of the article.

When this test is applied to a stool, or to a stool with a very low back, apply the backwards force horizontally to the front edge of the seat. Regardless of the shape of the seat, for stools with rectangular underframes apply the force perpendicular to each of two adjacent sides in turn, half the number of applications being applied to each side. For stools with triangular underframes apply the force along each of two median lines in turn.

Incline chairs fitted with tilting mechanisms at $15 \pm 5^\circ$ back from the vertical.

On the tenth application of the back force measure the relative deflection of the back, D , (see figure 10). Calculate the flexibility quotient D/H as illustrated in figure 10; where H is the distance from the seat surface to the top of the back and D is the deflection of the top of the back.

Additionally for all-foam chairs maintain the back load for 5 min or until creep movement has stopped, whichever is the longer. After this measure the distance, in millimetres,

between the face of the indenter whilst the load is applied, and the surface of the back when unloaded (measured before test).

NOTE 1. The deflection is measured during the back static strength test so that any plasticization of plastics components has been taken into account.

NOTE 2. Since one position of the seat loading pad in the seat static load test is the same as that specified for the back static load test, it is convenient to perform these two tests as a combined seat and back static load test (test 1).

NOTE 3. All-foam chairs are seating units composed essentially of flexible cellular material. Internal or external reinforcement or stiffening may be incorporated, but this does not function as a frame, i.e. loads applied in use are transmitted to the floor or base platform by the flexible foam, and not by structural components or other material. All-foam chairs are subject to creep, i.e. the phenomenon of slow distortion under sustained load. Therefore while support may be adequate immediately on sitting down, after a period of sitting it may gradually deform.

7.2 Test 2: arm and wing sideways static load tests

Apply two outward forces, H_a , of the appropriate magnitude specified in table 2 between the arms of the chair at the point along the arms most likely to cause failure. Apply the forces 10 times using the local loading pad (5.9) (see figure 11).

If the chair has wings, i.e. two side pieces at the top of the chair against which the head may be rested, repeat the test by applying the appropriate forces specified in table 2 outwards from the wings.

7.3 Test 3: arm downwards static load test

Apply a vertical force, V_a , of the appropriate magnitude specified in table 2, using the smaller seat loading pad (5.6), at the point along the arms most likely to cause a failure. Apply the force 10 times.

If the chair tends to overturn apply a balancing load large enough to prevent the chair from overturning when the full force is applied, on the side of the seat opposite to that on which the full force is applied (see figure 12).

7.4 Test 4: seat and back fatigue tests

NOTE. Because the number of cycles and the seat load are common to both the seat and back fatigue tests it is normally convenient to perform these two tests together as a combined seat and back fatigue test.

7.4.1 Test 4a: seat fatigue test. Apply the test force of 950 N by means of the seat loading pad (5.5) with the centre of the loading pad positioned at the seat loading point (see clause 6 and figure 13). Apply the force for the appropriate number of times specified in table 2.

If required, repeat the test on footrails or footrests at the appropriate test level.

7.4.2 Test 4b: back fatigue test. Position the centre of the back loading pad (5.7) either at the back loading point (see clause 6), or at 100 mm below the top of the back,