ANSI ICWM-2018 revision of ANSI ICWM-2012



Vocabulary, Performance and Testing Requirements for Casters and Wheels



An Industry Group of MHI 8720 Red Oak Blvd., Suite 201 Charlotte, NC 28217-3992 standards@mhi.org

#### American National Standard

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American National Standard

# Vocabulary, Performance and Testing Requirements for Casters and Wheels

Institute of Caster and Wheel Manufacturers (ICWM) An Industry Group of MHI

Approved June 11, 2018 American National Standards Institute, Inc. **FOREWORD**. This standard, which was developed under the American National Standards Institute (ANSI) Canvass method and approved by ANSI on June 11, 2018, represents suggested design practices and operational requirements for Casters and Wheels. It was developed by MHI, along with the Institute of Caster and Wheel Manufacturers ("ICWM"), one of its Industry Groups, and is intended to provide useful information and guidance for owners, users, designers, purchasers and/or specifiers of material handling equipment or systems. It is advisory only and should only be regarded as a simple tool that its intended audience may or may not choose to follow, adopt, modify, or reject. The following information does not constitute a comprehensive safety program, cannot guard against pitfalls in operating, selecting and purchasing such a system, and should not be relied upon as such. Such a program should be developed, and an independent adviser should be consulted in doing so.

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**The Institute of Caster and Wheel Manufacturers** (ICWM) is comprised of companies that design and manufacture casters and wheels. In 1996, the ICWM Long Range Planning Committee identified the need to develop a complete and comprehensive North American performance standard for casters and wheels.

Until this project was originally undertaken by the ICWM Standards Committee (September 1996), a comprehensive North American performance standard for casters and wheels did not exist. The ICWM Standards Committee, consisting of a cross section of the top engineers in the caster and wheel industry, met on an almost monthly basis for three and a half years to complete the work of producing the ICWM North American Performance Standard for Casters and Wheels.

The ICWM is an evolutionary refinement of the Caster & Floor Truck Manufacturers Association, which was founded in 1933 to educate members and users about the products of this industry and to maintain liaison with governmental agencies and other organizations. In 1950 the Association began developing standards for manual material handling products. Through the years, the Association and the Institute have developed a series of caster and wheel standards and standards for industrial trailer trucks, platform trucks, and towline trucks. ICWM cooperated with the General Service Administration, the Department of Defense, Post Office and other agencies in establishing federal and military specifications. In 1967 ICWM developed the American National Standards Institute's Industrial Caster Standard MH11.1.

At the date of approval of the 2018 revision of this standard, the ICWM consisted of the following member companies:

- Colson Group USA
- Darcor Limited
- E.R. Wagner Mfg. Co. Casters & Wheels
- Hamilton Caster & Mfg. Co.
- P&H Casters Company, Inc.
- Roll-Tech Molding Products, LLC
- RWM Casters
- Superior Tire & Rubber Corp.
- Tente Casters, Inc.

Questions or suggestions for improvement regarding this standard are welcome. They should be sent to: ICWM Standard Committee, MHI, 8720 Red Oak Blvd., Suite 201, Charlotte, NC, 28217 or standards@mhi.org.

# Vocabulary, Performance and Testing Requirements for Casters and Wheels

# **Table of Contents**

1	Purpose ar	nd scope	1
	1.1 Purp	oose	1
	1.2 Equi	pment covered	1
2	Normative	, references	1
3	Definitions		2
	3.1 Defi	nitions relating to wheels and constituent parts	2
	3.1.1	Wheel	2
	3.1.2	Hub	2
	3.1.3	Rim	2
	3.1.4	Web	3
	3.1.5	Core	3
	316	Tire	3
	3.1.7	Tread	3
	3.1.8	Wheel bearing	4
	3.2 Defi	nitions related to wheel construction	4
	321	Solid wheel (bare wheel)	4
	322	Composite wheel	
	323	Flange wheel	5
	324	Single-flanged rail wheel	6
	325	Grooved wheel	6
	326	Electric conductive wheel	6
	327	Flame-retardant wheel	6
	328	l oad wheel	6
	329	Stabilizer wheel	6
	3 2 10	Guide wheel	0
	3.3 Dim	ensional characteristics of the wheel	7
	3.3.1	Diameter (D)	7
	3.3.2	Wheel hub diameter (M)	7
	3.3.3	Bore diameter (d)	7
	3.3.4	Bearing seat dimensions (s x t)	
	3.3.5	Wheel width	8
	3.4 Defi	nitions relating to axle and mountings	10
	3.4.1	Axle	10
	3.4.2	Fork mounting	10
	3.4.3	Stub-axle mounting	10
	3.4.4	Dual wheel stub-axle mounting	10
	3.5 Defi	nitions relating to casters	11
	3.5.1	Caster	11
	3.5.2	Rigid caster	11
	3.5.3	Swivel caster	11
	3.5.4	Dual-wheel caster	11
	3.5.5	Inclined axle caster	11
	3.5.6	Housing/rig	12
	3.5.7	Fork	12
	3.5.8	Mounting plane	12
	3.5.9	Top plate	12

	3.5.10 Stem	1	13
	3.5.11 Hollow k	ingpin1	13
	3.5.12 Swivel a	xis	13
	3.5.13 Swivel b	earing1	13
	3.6 Definitions for	caster accessories1	13
	3.6.1 Threadg	uard1	13
	3.6.2 Braking	or locking devices1	14
	3.6.3 Shock-al	bsorbing caster1	16
	3.6.4 Controlli	ng the steering attachment	16
	3.6.5 Foot qua	ard 1	17
	366 Wheel h	ood	17
	367 Dual-wh	eel caster with a pivoting axle	17
	3.7 Dimensional of	characteristics of the caster	18
	37.1 Overall h	neight	18
	372 Offset	1	18
	373 Swivel ra	adius	18
	374 Fork wid	th (lea spacina)	19
	375 Outer dir	mensions (A x B or C x D) $(A = A + B + B + B + B + B + B + B + B + B +$	19
	376 Attaching	n holt diameter	10
	377 Bolt-bole	spacing (F x F or K x I )	10
	378 Stem dia	ameter	20
	379 Stem len	anth	20
	3.7.10 Hollow k	inggin mounting	20
	2.8 Load capacity	,	20
	3.0 Woight		<u>-</u> 0 21
	3.10 Forces		⊥ I 21
	3 10 1 Start-roll	ing force	-⊥ 21
	3.10.7 Start-Tol		-⊥ 21
	3 10 3 Swivel fo		-⊥ 21
л	Test annaratus and	conditions	£1 21
4	1 d Sequence of t	posts for all castors	22 22
	4.1 Sequence of t	et	22
	4.2 Wheel play te	ct	22
	4.5 Swiver play le	SI	20
	4.4 Conductivity test		20
	4.5 Conductivity to	zol	24
	4.0 Wheel blake a	r looking fotigue toot	24 25
	4.7 Draking anu/0		20
	4.0 Dynamic test.		20
	4.9 Static test	۷۲ م	27 27
	4.10 Side Idad lest	vertical impact test	27 27
5	4.11 Castel/wheel	- verilical impact lest	<u>イ</u> 1 つつ
5	Fulfillule chair caste	sis – lest procedule and acceptance chiena	20
	5.1 Calegones		20
	5.2 Dimensions	aral raquiramenta	20
	5.3 Testing – gen		29
	5.4 Test procedur		29
	5.4.1 Dynamic	; test procedure	29
	5.4.2 Acceptar		29
		inpact lest	JU ≥√
	5.4.4 Caster re	clention	ן כ זיר
c	5.4.5 Conduct	IVILY LESI	21
ю	industrial casters – t	est procedures and acceptance criteria	51
	o.1 vvneel play te	SI	31
	6.1.1 Lest pro	ceaure	31
	6.1.2 Acceptar	nce criteria	32
	6.2 Swivel play te	st	32

	6.2.1	Test procedure	32
	6.2.2	Acceptance criteria	
	6.3 Rolla	ability test	
	6.3.1	Test procedure	
	6.3.2	Acceptance criteria	
	6.4 Con	ductivity test	
	6.4.1	Test procedure	
	642	Acceptance criteria	34
	643	limitation	
	6.5 Whe	el brake efficiency test	
	651	Test procedure	
	652	Accentance criteria	35
	6.6 Brak	ring and/or locking device fatigue test	
	661	Test procedure	
	662	Accentance criteria	
	67 Brok	vo opgogo/dicopgogo force test	
	0.7 Diak	Test presedure	
	670	Acceptance criteria	
	0.7.Z		
	0.8 Stati		
	6.8.1	l est procedure	
	6.8.2	Acceptance criteria	
	6.9 Dyna		
	6.9.1	Dynamic test – industrial casters at or under 2.5 mph (4 kph)	
	6.9.2	Dynamic test – industrial caster over 2.5 mph (4 kph)	
	6.10 Side	load test	
	6.10.1	Test procedure	
	6.10.2	Acceptance criteria	
	6.11 Cast	ters – vertical impact test	
	6.11.1	Test procedure	
	6.11.2	Acceptance criteria	
	6.12 Whe	eels – vertical impact test	
	6.12.1	Test procedure	
	6.12.2	Acceptance criteria	39
	6.13 V-gr	ooved wheel test	
	6.13.1	Test procedure	
	6.13.2	Acceptance criteria	40
7	Institutiona	I and medical equipment casters - test procedures and acceptance criteria	40
	7.1 Whe	el play test	40
	7.1.1	Test procedure	40
	7.1.2	Acceptance criteria	41
	7.2 Swiv	/el plav test	41
	7.2.1	Test procedure	41
	7.2.2	Acceptance criteria	
	7.3 Rolla	ability test	42
	7.3.1	Test procedure	
	7.3.2	Acceptance criteria	43
	74 Whe	el brake efficiency test	43
	741		43
	742	Accentance criteria	
	75 Swiv	val lock afficiency test	
	751	Test procedure	43 //
	7.0.1	Accentance criteria	
	76 Brok	ring and/or locking dovice fatigue test	
	7.0 Brak	Test procedure	
	7.0.1	Lesi procedure	
	7.0.2		
	1.1 Stati	เว เฮรเ	44

	7.7.1	Test procedure	44
	7.7.2	Acceptance criteria	44
	7.8 Dyna	amic test	45
	7.8.1	Test procedure	45
	7.8.2	Acceptance criteria	45
	7.9 Con	ductivity test	45
	7.9.1	Test procedure	45
	7.9.2	Acceptance criteria	46
	7.9.3	Disclaimer	46
	7.10 Cast	ters – vertical impact test	46
	7.10.1	Test procedure	46
	7.10.2	Acceptance criteria	46
	7.11 Whe	els – vertical impact test	46
	7.11.1	Test procedure	46
	7.11.2	Acceptance criteria	47
8	Business n	nachine and shopping cart casters - test procedures and acceptance criteria	47
	8.1 Busi	ness machine wheel or caster test	47
	8.1.1	Ramp impact test procedure	47
	8.1.2	Obstacle impact test procedure	47
	8.1.3	Acceptance criteria	47
	8.2 Sho	pping cart wheel test	47
	8.2.1	Test procedure	47
	8.2.2	Acceptance criteria	48
	8.3 Sho	pping cart wheel flat spot test	48
	8.3.1	Test procedure	48
	8.3.2	Acceptance criteria	48

# Vocabulary, Performance and Testing Requirements for Casters and Wheels

# 1 Purpose and scope

# 1.1 Purpose

This standard provides manufacturers, specifiers and users with a common basis for evaluating the safety, durability, structural adequacy, and technical requirements for group-specific casters and wheels. The standard defines industry terms, specific tests, equipment/methods that can be used, the conditions of tests, and minimum acceptance levels to be used in evaluating these products.

#### 1.2 Equipment covered

This standard addresses the total range or market for casters and wheels for these categories:

- a) furniture chair casters;
- b) industrial casters (at or under 2.5 mph and over 2.5 mph);
- c) institutional and medical equipment casters; and
- d) business machine and shopping cart casters.

This standard includes a glossary of caster and wheel terms, definitions, symbols and dimensions. Additionally, appropriate caster and wheel test equipment, procedures and methods are delineated and incorporated into this standard.

# 2 Normative references

The following standards and documents contain provisions which, through reference in this text, constitute provisions of this American National Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this American National Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below.

ANSI/BIFMA X5.1, Office Chairs

BS EN 12526, Castors and wheels. Vocabulary, recommended symbols and multilingual dictionary

BS EN 12527, Castors and wheels. Test methods and apparatus

BS EN 12528, Castors and wheels. Castors for furniture. Requirements

BS EN 12529, Castors and wheels. Castors for furniture. Castors for swivel chairs. Requirements

BS EN 12530, Castors and wheels. Castors and wheels for manually propelled institutional applications

BS EN 12531, Castors and wheels. Hospital bed castors

BS EN 12532, Castors and wheels. Castors and wheels for applications up to 1,1 m/s (4 km/h)

BS EN 12533, Castors and wheels. Castors and wheels for applications over 1,1 m/s (4 km/h) and up to 4,4 m/s (16 km/h)

FFC-88-C, Federal Specification – Casters, Rigid and Swivel, Industrial Duty

UL 94, Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances

# 3 Definitions

For the purposes of this standard, the following terms and definitions apply.

# 3.1 Definitions relating to wheels and constituent parts

# 3.1.1 Wheel

Circular structure able to rotate on an axle (3.4.1), either directly or with the use of bearing(s) (3.1.8). The external part of the structure is in contact with the ground. See Figure 1:



Figure 1: Wheel

# 3.1.2 Hub

Central part of the wheel (3.1.1) to receive the axle (3.4.1) or wheel bearing(s) (3.1.8). See Figure 2:



Figure 2: Hub

# 3.1.3 Rim

The outer profile of a core (3.1.5), connected to the hub (3.1.2) by a web (3.1.4). See Figure 3:



Figure 3: Rim

# 3.1.4 Web

Part of the wheel (3.1.1) between the hub (3.1.2) and the rim (3.1.3). See Figure 4:



Figure 4: Web

# 3.1.5 Core

Part of the wheel (3.1.1) comprising the hub (3.1.2), web (3.1.4) and the rim (3.1.3) suitable to receive a tire (3.1.6). See Figure 5:



Figure 5: Core

# 3.1.5.1 Solid core

Core (3.1.5) made from only one material.

# 3.1.5.2 Composite core

Core (3.1.5) made from assembled parts.

# 3.1.6 Tire

Outer part of a wheel (3.1.1), the material of which can be different from the core (3.1.5), which can be fixed or de-mountable.

# 3.1.6.1 Solid tire

Tire (3.1.6) not containing air.

# 3.1.6.2 Semi-pneumatic tire

Tire (3.1.6) with cavity containing air to zero pressure.

# 3.1.6.3 Foam tire

Tire (3.1.6) having an open or closed cellular structure.

# 3.1.6.4 Pneumatic tire

Tire (3.1.6) suitable to contain air at a pressure, which can be adjusted.

# 3.1.7 Tread

Outer surface of a wheel (3.1.1) or a tire (3.1.6), in contact with the ground. See Figure 6:



Figure 6: Tread

# 3.1.8 Wheel bearing

Device(s) intended to ease the rotation of a wheel (3.1.1) around its axle (3.4.1); for example, sleeve and self-lubricated bearings, ball bearings, roller bearings, etc. See Figure 7:











Flanged Ball Bearing

Tapered Roller Bearing

Plain Bearing

**Roller Bearing** 

g Ball Bearing



9.....

# 3.2 Definitions related to wheel construction

The following are examples of the most frequently used wheels.

# 3.2.1 Solid wheel (bare wheel)

Wheel (3.1.1) made of metal, plastic, rubber, polyurethane or other materials that are used without any added tire (3.1.6).

# 3.2.2 Composite wheel

Wheel (3.1.1) comprised of a core (3.1.5) and a tire (3.1.6). See Figure 8:



Figure 8: Composite Wheel

# 3.2.2.1 Bonded/mold-on tire wheel

Wheel (3.1.1) with a tire (3.1.6) permanently fixed to the rim (3.1.3). See Figure 9:



Figure 9: Bonded/Mold-on (Permanently Tired) Tire Wheel

# 3.2.2.2 De-mountable tire wheel

Wheel (3.1.1) with a tire (3.1.6) that is detachable. See Figure 10:



Figure 10: De-mountable Tire Wheel

# 3.2.2.3 Press-on tire wheel

Wheel (3.1.1) comprised of a core (3.1.5) with a tire (3.1.6) that is interference-fit to the hub and slid onto the wheel axially. See Figure 11:



Figure 11: Press-on Tire Wheel

# 3.2.3 Flange wheel

Wheel (3.1.1) with a connecting web (3.1.4) suitable for fitting to a hub (3.1.2) or stub axle. See Figure 12:



Figure 12: Flange Wheel

# 3.2.4 Single-flanged rail wheel

Wheel (3.1.1) designed to run on a rail or guiding track. See Figure 13:



Figure 13: Single-Flanged Rail Wheel

# 3.2.5 Grooved wheel

Wheel (3.1.1) designed to run on various rail profiles or used with ropes or cables. See Figure 14:



Figure 14: Grooved Wheel Revise

# 3.2.6 Electric conductive wheel

Wheel (3.1.1) with controlled electrical resistance, used to dissipate static electricity.

# 3.2.7 Flame-retardant wheel

Wheel (3.1.1) with its components meeting the requirements set forth in UL94, V-1.

# 3.2.8 Load wheel

Wheel (3.1.1), which bears the dynamic and static loads of the vehicle to which it is fitted.

# 3.2.8.1 Drive wheel

Load wheel connected directly or through a clutch, to the power system, which provides the torque necessary for transmission of motion.

# 3.2.8.2 Steer wheel

Free running wheel (3.1.1), connected to a steering device, which controls the running direction of the vehicle to which it is fitted.

# 3.2.8.3 Drive steer wheel

Load wheel connected to the power system(s) and to a steering device, which performs the duties as in 3.2.8.1 and 3.2.8.2 simultaneously.

# 3.2.9 Stabilizer wheel

Wheel (3.1.1) solidly or resiliently mounted on a chassis of a vehicle; used to assist in maintaining stability.

# 3.2.10 Guide wheel

Wheel (3.1.1) to control the movement of the vehicle along a pre-determined path.

# 3.3 Dimensional characteristics of the wheel

# 3.3.1 Diameter (D)

Nominal straight-line distance passing from outside to outside through the center of a circle. See Figure 15:



Figure 15: Diameter

#### 3.3.2 Wheel hub diameter (M)

Smallest diameter of the hub (3.1.2). See Figure 16:



Figure 16: Hub Diameter

# 3.3.3 Bore diameter (d)

Nominal diameter (d) of the hole through the hub (3.1.2), or nominal diameter of the bearing(s) (3.1.8) to receive the axle (3.4.1). See Figure 17:



Figure 17: Bore Diameter

# 3.3.4 Bearing seat dimensions (s x t)

Nominal diameter and depth of the seat to receive the bearing(s) (3.1.8). See Figure 18:



Figure 18: Bearing Seat Dimensions

# 3.3.5 Wheel width

Widest part of the wheel (3.1.1), either the hub width T1 (3.3.5.1), or tread width T2 (3.3.5.2).

# 3.3.5.1 Hub width (T1)

Widest part of the hub (3.1.2), including bearing assembly (3.1.8) and threadguards (3.6.1), if fitted. See Figure 19:



#### 3.3.5.2 Tread width (T2)

Width of the tire (3.1.6) measured at the widest point and parallel to the revolving axis. See Figure 20:



Figure 20: Tread Width

# 3.3.5.3 Contact area (T3)

Area of the tread touching the surface (3.1.7). See Figure 21:



Figure 21: Contact Area

# 3.3.5.4 Tire profile

The shape of the tire or tread on its outer diameter (3.3.1) usually flat, round or crowned.

# 3.4 Definitions relating to axle and mountings

#### 3.4.1 Axle

A circular sectional part on which the wheel may revolve either directly or with the use of anti-friction bearings.

# 3.4.2 Fork mounting

Assembly where the axle (3.4.1) is supported on both sides of the wheel hub (3.1.2). See Figure 22:



Figure 22: Fork Mounting

# 3.4.3 Stub-axle mounting

Assembly to support the axle (3.4.1) only on one side of the hub (3.1.2). See Figure 23:



Figure 23: Stub-Axle Mounting

# 3.4.4 Dual wheel stub-axle mounting

Assembly to support the axle (3.4.1) installed between two wheels (3.1.1). See Figure 24:



Figure 24: Dual Wheel Stub-Axle Mounting

# 3.5 Definitions relating to casters

# 3.5.1 Caster

Assembly comprising a housing/rig (3.5.6), one or more wheels (3.1.1), an axle (3.4.1) and, if required, accessories (3.6).

# 3.5.2 Rigid caster

Assembly including one or more wheels (3.1.1) in a non-swiveling housing/rig (3.5.6). See Figure 25:



Figure 25: Rigid Caster

# 3.5.3 Swivel caster

Assembly including one or more wheels (3.1.1) in a housing/rig (3.5.6), which rotates freely around a vertical axis. The axis of the wheel(s) (3.1.1) is normally offset (3.7.2) to the swivel axis (3.5.12) of the fork (3.5.7) as shown in Figure 46. See Figure 26:



Figure 26: Swivel Caster

# 3.5.4 Dual-wheel caster

Swivel or rigid assembly including two wheels (3.1.1), which rotate independently. See Figure 27:



Figure 27: Dual-Wheel Caster

# 3.5.5 Inclined axle caster

Assembly in a swivel housing/rig (3.5.6) which rotates freely around its vertical axis. The axis of the wheel, which is inclined to the ground, is offset to the swivel axis (3.5.12). See Figure 28:



Figure 28: Inclined Axle Caster

# 3.5.6 Housing/rig

Swivel or rigid assembly, designed to be connected to mobile equipment. See Figure 29:



Figure 29: Housing/Rig

# 3.5.7 Fork

Supporting structure with one or more legs designed to accommodate an axle (3.4.1) and wheel(s) (3.1.1).

# 3.5.8 Mounting plane

Surface of the caster (3.5.1) or housing/rig (3.5.6) to be connected to mobile equipment.

# 3.5.9 Top plate

Upper part of a housing/rig (3.5.6), with or without holes or slots for connection to the equipment. See Figure 30:



Figure 30: Top Plate

#### 3.5.10 Stem

Vertical upper part of a housing/rig (3.5.6) to fit into a socket, threaded boss, or other receptacle in mobile equipment. See Figure 31:



Figure 31: Stem

#### 3.5.11 Hollow kingpin

Through-hole on the upper side of the housing/rig (3.5.6) suitable for the connection to mobile equipment. See Figure 32:



Figure 32: Hollow Kingpin

# 3.5.12 Swivel axis

Vertical axis around which the fork (3.5.7) rotates.

#### 3.5.13 Swivel bearing

Device that allows the free rotation of the fork (3.5.7) around its swivel axis (3.5.12).

# 3.6 Definitions for caster accessories

#### 3.6.1 Threadguard

Circular shielding components, assembled on the sides of a wheel (3.1.1) to protect the hub (3.1.2) from threads and other foreign objects, which may prevent free rotation of the wheel (3.1.1).

# 3.6.2 Braking or locking devices

Devices to prevent the rotation of the housing/rig (3.5.6) around the swivel axis (3.5.12), or the rotation of the wheel(s) (3.1.1) or both.

# 3.6.2.1 Wheel braking and/or locking device

Device to prevent the wheel(s) (3.1.1) from rotating, leaving the housing/rig (3.5.6) free to swivel, intended to be used only as a parking brake. See Figure 33:



Figure 33: Wheel Braking or Locking Device

#### 3.6.2.2 Dynamic brake

Device to be used to slow down or stop wheel(s) (3.1.1) in motion. This device can also be used as a parking brake. Note that this standard does not include specifications for dynamic brakes. See Figure 34:



Figure 34: Dynamic Brake

# 3.6.2.3 Central braking or locking device

Device within the caster (3.5.1), to operate through the swivel axis (3.5.12) that prevents either the rotation of the swivel housing/rig (3.5.6), the wheel(s) (3.1.1) or both, intended to be used only as a parking brake.

# 3.6.2.4 Total braking or locking device

Device to simultaneously prevent the rotation of the wheel(s) (3.1.1) and the swivel housing/rig (3.5.6). This device is intended to be used only as a parking brake. See Figure 35:



Figure 35: Total Braking or Locking Device

# 3.6.2.5 Directional locking device

Device to prevent the rotation of the fork (3.5.7) of a swivel caster (3.5.3) in one or more predetermined positions. This device can be used to convert a swivel caster (3.5.3) to a rigid caster (3.5.2). See Figure 36:



Figure 36: Directional Locking Device

# 3.6.2.6 Braking device for office chairs

Device to prevent the wheel(s) (3.1.1) from rotating when the chair is unloaded. See Figure 37:



Figure 37: Braking Device for Office Chairs

# 3.6.2.7 Central braking and/or locking device for hospital beds

Device to control the caster (3.5.1) by means of a mechanism through the stem (3.5.10), allowing three alternative functions: total braking/locking as in 3.6.2.4, directional locking as in 3.6.2.5, or no braking/locking action of the housing/rig (3.5.6) or wheel(s). See Figure 38:



Figure 38: Central Braking or Locking Device for Medical Equipment

# 3.6.3 Shock-absorbing caster

Caster (3.5.1) specifically designed to absorb shocks and impacts. See Figure 39:



Figure 39: Shock-Absorbing Caster

# 3.6.4 Controlling the steering attachment

Device for controlling the rotation of the housing/rig (3.5.6). See Figure 40:



Figure 40: Steering Attachment

# 3.6.5 Foot guard

Device, integral with the fork (3.5.7) to minimize interference between a wheel and other objects. See Figure 41:



Figure 41: Foot Guard

# 3.6.6 Wheel hood

Device to cover the wheel (3.1.1). See Figure 42:



Figure 42: Wheel Hood

# 3.6.7 Dual-wheel caster with a pivoting axle

Caster (3.5.1) with dual wheel(s) (3.1.1) on a stub-axle mounting (3.4.3) with a central fulcrum. See Figure 43:



Figure 43: Dual-Wheel Caster with a Pivoting Axle

# 3.7 Dimensional characteristics of the caster

# 3.7.1 Overall height

Distance measured vertically between the ground and mounting plane (3.5.8) of a caster. See Figure 44:



Figure 44: Overall Height

#### 3.7.2 Offset

Distance measured horizontally between the vertical swivel (swivel lead) axis (3.5.12) of the caster (3.5.1) and the axis of the wheel(s) (3.1.1). See Figure 45:



Figure 45: Offset

#### 3.7.3 Swivel radius

Distance measured horizontally, between the vertical swivel axis (3.5.12) and the most protruding point of the caster (3.5.1) or its accessories. This radius defines the minimum circle in which the caster is free to rotate through 360°. See Figure 46:



Figure 46: Swivel Radius

# 3.7.4 Fork width (leg spacing)

Distance between the inner surfaces of the legs of the fork (3.5.7), measured along the axis of the wheel(s) (3.1.1). See Figure 47:



Figure 47: Fork Width

# 3.7.5 Outer dimensions (A x B or C x D)

Dimensions of the top plate (3.5.9). See Figure 48:



Figure 48: Top Plate Outer Dimensions

# 3.7.6 Attaching bolt diameter

Diameter of the attaching bolts to connect the caster to the equipment through the round or slotted holes in the top plate (3.5.9).

# 3.7.7 Bolt-hole spacing (E x F or K x L)

Distance between the axes of the top plate (3.5.9) bolt holes. See Figure 49:





Figure 49: Bolt-Hole Spacing

# 3.7.8 Stem diameter

Diameter (3.3.1) of the stem (3.5.10). See Figure 50:



Figure 50: Stem Diameter

#### 3.7.9 Stem length

Length of the stem (3.5.10) above the mounting plane (3.5.8). See Figure 51:



Figure 51: Stem Length

#### 3.7.10 Hollow kingpin mounting

Diameter of the bolt used to connect the caster (3.5.1) to the equipment through a hollow kingpin (3.5.11). See Figure 52:



Figure 52: Hollow Kingpin Mounting

# 3.8 Load capacity

Maximum rated load in pounds or kilograms, which can be carried by a wheel (3.1.1) or a caster (3.5.1). See Figure 53:



Figure 53: Load Capacity

# 3.9 Weight

Relative weight of the wheel (3.1.1) or caster (3.5.1), in pounds or kilograms. See Figure 54:



Figure 54: Weight

# 3.10 Forces

# 3.10.1 Start-rolling force

Force required to cause forward rotation of the caster wheel.

# 3.10.2 Keep-rolling force

Force required to maintain forward caster wheel rotation after initial rotation.

# 3.10.3 Swivel force

Force required to swivel a caster 90°.

# 4 Test apparatus and conditions

This clause establishes the basic design requirements for the various apparatus types used to test casters and wheels. Refer to 5 through 8 for the testing procedures and acceptance criteria for specific types of casters as follows:

- 5 Furniture chair casters
- 6 Industrial casters
- 7 Institutional and medical equipment casters
- 8 Office equipment and grocery cart casters

Recording instruments, weights, loads, gages, timing devices and measuring devices shall be calibrated in accordance with the manufacturer's requirements. All tests shall be performed within an ambient temperature range of 65-75°F (18-24°C) unless otherwise specified within a test section.

# 4.1 Sequence of tests for all casters

The following test procedures are covered under this standard. A manufacturer may select which of the test(s) will be run on a particular caster.

- initial wheel play test (4.2)
- initial swivel play test (4.3)
- rollability test (4.4)
- conductivity test (4.5)
- initial wheel brake efficiency test (4.6)
- initial swivel lock efficiency test (4.6)
- braking and/or locking device fatigue test (4.7)
- dynamic test (4.8)
- static test (4.9)
- final wheel brake efficiency test (4.6)
- final swivel lock efficiency test (4.7)
- final wheel play test (4.2)
- final swivel play test (4.3)
- side load test (4.10)
- caster vertical impact test (4.11)
- wheels vertical impact test (4.11)

# 4.2 Wheel play test

This test establishes the basic requirements for an apparatus to measure wheel play at the beginning of the test sequence and at the end of the test sequence.

- **4.2.1** The test fixture shall be so constructed as to rigidly fix the caster assembly in a horizontal or vertical position.
- **4.2.2** A suitable measuring device accurate to 0.001 in. (0.0254 mm), shall be clamped to the fixture to record the amount of movement as the wheel is tilted from side to side.
- **4.2.3** The linear measurement shall be taken at the farthest point from and parallel to the axle (refer to Figure 55). This measurement must be converted to an angular dimension for Acceptance Criteria.



Figure 55: Wheel Play Test Apparatus

# 4.3 Swivel play test

This test establishes the basic requirements for an apparatus to measure the swivel play at the beginning of the test sequence and at the end of the test sequence.

Swivel play is the amount of vertical play between the mounting attachment and the caster housing/rig. This measurement is reported in degrees.

- **4.3.1** The apparatus consists of an amplifying bar at least 7.87 in. (200 mm) long, an indicator accurate to 0.001 in. (0.0254 mm) and a securing device.
- **4.3.2** The caster is to be secured such that the mounting attachment is free rotating and horizontal.
- **4.3.3** Refer to Figure 56 as an example of the testing position and apparatus.



Figure 56: Swivel Play Test Apparatus

#### 4.4 Rollability test

This test establishes the basic requirements for an apparatus to measure the rolling and swiveling performance of a caster at its load capacity.

- **4.4.1** The apparatus for rolling and swiveling forces shall be constructed to accommodate one or more swivel casters.
- **4.4.2** The test machine shall be constructed so that the test plane is horizontal and the calibrated force gage shall be applied to the caster parallel to the test plane and positioned as close to the wheel axis as possible.

- **4.4.3** The test surface should be smooth steel and parallel to the mounting plane of the caster.
- **4.4.4** The test machine shall be rigid enough to prevent any deflection that would affect the accuracy of the test.
- **4.4.5** A weight equal to the load capacity is applied through dead weights or hydraulic, electromechanical, or pneumatic means (refer to Figure 57).



Figure 57: Rollability Test Apparatus

Note: The apparatus shown is for illustration only.

#### 4.5 Conductivity test

This test establishes basic requirements of the testing apparatus used to conduct electrostatic measurements of wheels and casters.

This test measures the surface electrical resistance of a wheel and/or caster.

- **4.5.1** The wheel shall be tested while supporting a load of 25% of its load capacity.
- **4.5.2** The caster to be tested shall be rolled onto a clean, dry, insulated, flat steel plate.
- **4.5.3** The metal plate and the mounting plane (3.5.8) of the caster shall form the electrodes for the test.
- **4.5.4** The resistance between electrodes shall be measured by any resistance measuring apparatus of a suitable range.

#### 4.6 Wheel brake and swivel lock efficiency test

This test establishes the basic requirements for the apparatus used to determine the performance of the wheel-braking and swivel-lock devices.

This test apparatus applies to casters supplied with a device that locks the rotational movement of the wheel, the swivel, or both the wheel and the swivel.

**4.6.1** The apparatus shall provide fixtures that allow the caster to be mounted by its normal attachments.

- **4.6.2** The apparatus shall provide a wheel contact surface that is flat and smooth.
- **4.6.3** The apparatus shall provide a force equal to the load capacity of the caster perpendicular to the mounting plane and the test surface.
- **4.6.4** The apparatus shall provide the capability to attach a calibrated force gage to the caster parallel to the test surface.
- **4.6.5** The test apparatus must be constructed so that the horizontal force may be applied at 90° increments and the friction inherent in the machine is subtracted (refer to Figure 58).



Figure 58: Wheel Brake and Swivel Lock Efficiency Test Apparatus

#### 4.7 Braking and/or locking fatigue test

This test establishes the basic design requirements for the apparatus used to fatigue test braking and/or locking mechanisms for casters.

This test apparatus applies to casters supplied with a device that locks the rotational movement of the wheel, the swivel, or both the wheel and the swivel.

- **4.7.1** The apparatus shall provide fixtures that allow the caster to be mounted by its normal attachments.
- **4.7.2** The apparatus must cycle the braking or locking device through its entire range of motion.
- **4.7.3** Test apparatus will allow continuous cycling from the braking to the non-braking position (refer to Figure 59).



Figure 59: Braking and/or Locking Fatigue Test Apparatus

Note: The apparatus shown is for illustration only.

#### 4.8 Dynamic test

This test establishes the basic requirements of the apparatus to conduct dynamic testing. *No artificial cooling shall be used on the caster or wheel.* 

This test apparatus establishes the maximum dynamic load that can be carried by the caster with a load rating of less than 5,000 lb. (2270 kg).

- **4.8.1** The apparatus shall provide fixtures that allow the caster to be mounted by its normal attachments.
- **4.8.2** The test surface shall be smooth steel and parallel to the mounting plane (3.5.8) of the caster.
- **4.8.3** The apparatus shall provide a force equal to the dynamic load capacity of the caster perpendicular to the mounting plane and the test surface. The use of dead weight is recommended for dynamic testing. If pneumatic or hydraulic loads are applied, then a closed loop correction system must be used.
- **4.8.4** The test machine should be rigid enough to prevent any deflection that would affect the accuracy of the test.
- **4.8.5** Refer to the appropriate dynamic test for surface speed. The surface speed shall remain constant throughout the test.
- **4.8.6** The track configuration is open. The track can be linear or circular, horizontal or vertical.
- **4.8.7** A device that records cycles and/or time should be used to measure test time.
- **4.8.8** Refer to section(s) 6.9.1, 6.9.2 and 7.8.1 for obstacle size and orientation.

#### 4.9 Static test

This test establishes the basic requirements of the apparatus used to conduct static loading.

This test apparatus establishes the maximum static load that can be carried and meet the minimum standards set forth, with no functional impairment to the caster.

- **4.9.1** The apparatus shall provide fixtures that allow the caster to be mounted by its normal attachments.
- **4.9.2** The test surface shall be smooth steel and parallel to the mounting plane (3.5.8) of the caster.
- **4.9.3** The apparatus shall provide a force equal to four (4) times the load capacity of the caster applied perpendicular to the mounting plane and the test surface.
- **4.9.4** The test machine should be rigid enough to prevent any deflection that would affect the accuracy of the test.

#### 4.10 Side load test

This test establishes the basic requirements for the apparatus used to conduct a side-load test on a rigid caster.

The side load is the maximum transverse force that a rigid caster can withstand before permanent deformation is encountered (refer to Figure 60).

- **4.10.1** The test apparatus shall be capable of applying a compressive load parallel to the wheel axis and at the axle.
- **4.10.2** The mounting fixture shall be sufficiently rigid so that its deflection, due to the load applied to the caster, can be ignored.
- **4.10.3** The load can be applied by means of dead weights or electromechanical, hydraulic, or pneumatic means such that a successive increase in load can be applied up to the load capacity of the caster.
- **4.10.4** A recording instrument with a range up to 1 in. (254 mm) travel, and accurate to 0.001 in. (0.0254 mm), shall be used in conjunction with compressive force.



Figure 60: Side Load Test Apparatus

#### 4.11 Caster/wheel – vertical impact test

This test establishes the basic test apparatus used to conduct a vertical impact test on casters and wheels.

This test measures the impact resistance of casters and wheels with a load rating of less than 5,000 lb. (2,270 kg).

- **4.11.1** A device that transmits force, usually measured in lbf (N), to the test caster/wheel from a free-falling weight (refer to Figure 61 for orientation).
- **4.11.2** The apparatus can be any design that will allow a guided free-falling weight to drop on the supported caster/wheel.
- **4.11.3** A measuring device to determine free fall distance is to be mounted parallel to the free fall weight path (refer to Figure 61 for orientation).
- 4.11.4 The mounting fixture must be rigid enough to prevent deflection during the impact test.



Figure 61: Vertical Impact Test Apparatus

# 5 Furniture chair casters – test procedure and acceptance criteria

This clause applies to casters that will normally be used in home/office environments for chair applications only. It covers categories, dimensions, and testing procedures.

# 5.1 Categories

Office furniture casters are classified into categories based on wheel diameter:

- a) Single wheel 2 in. (5 cm);
- b) Single wheel 21/2 in. (6.25 cm);
- c) Single wheel 3 in. (7.5 cm);
- d) Dual wheel 2 in. (5 cm); and
- e) Dual wheel 21/2 in. (6. 25 cm).

#### 5.2 Dimensions

Allowable dimensions for office furniture casters are as follows:

	Diameter Dimension in inches (cm)		
Wheel Configuration	Minimum	Maximum	
Single Wheel	2.0 (5.0)	3.0 (7.5)	
Dual Wheel	2.0 (5.0)	2.5 (6.25)	

#### 5.3 Testing – general requirements

The manufacturer shall be free to choose the design, raw materials, surface treatments, embellishments, and methods of manufacture used so long as the requirements of this standard are met.

**5.3.1** All tests must be conducted with the same caster.

**5.3.2** No caster or part of a caster shall become detached during the test. Each caster shall be capable of carrying out its normal function at the end of the test program.

#### 5.4 Test procedures and acceptance criteria

#### 5.4.1 Dynamic test procedure

The dynamic test procedure for furniture chair casters as specified in ANSI/BIFMA X5.1 shall be conducted as follows:

- **5.4.1.1** Attach the chair base with casters to a cycling device as shown in Figure 62. If the casters have hard treads (greater than or equal to 90 Shore A), conduct the test with a smooth, hard surface on the test platform. If casters have soft treads, mount three obstacles on the test platform in accordance with the layout (refer to Figure 62).
- **5.4.1.2** Apply a load of 300 lb. (136 kg), including the hopper (the unit that holds the weight), to the chair base. The base and casters shall be free to rotate and swivel.
- **5.4.1.3** Adjust the length of stroke of the cycling device to ensure 30 in. (75 cm) of travel. On tests for soft tread casters, this travel shall be oriented with the obstacles (refer to Figure 62).
- **5.4.1.4** Operate the machine at a rate of  $9 \pm 1$  cycles per minute. One cycle shall consist of a forward and a backward stroke of the machine. If the casters have hard treads, cycle the device for 100,000 cycles. If the casters have soft treads, cycle the device for 36,000 cycles. Findings shall be recorded in accordance with the acceptance level in ANSI/BIFMA X5.1 (refer to Figure 62).

#### 5.4.2 Acceptance criteria

Furniture chair casters shall comply with ANSI/BIFMA X5.1 requirements. The acceptance criteria outlined in ANSI/BIFMA X5.1-2017 states, "There shall be no loss of serviceability."



Figure 62: Dynamic Test Apparatus for Furniture Chair Casters

# 5.4.3 Vertical impact test

In this test, a caster is rigidly mounted by its normal attachment to a test fixture such that a free-falling weight can strike the tread of the wheel(s). In the case of a twin wheel caster, both wheels should be struck simultaneously.

Evaluate minimum standards for vertical impact strength, in-lbf. or N-m, as outlined in Table 1. The caster shall have no loss of function or serviceability and show no visible signs of fracture.

Wheel	Diameter in		Minimum Impact
Configuration	inches (cm)	Tread	in-lbf (N-m)
Single	2.0 (5.0)	Soft	180 (20.3)
Single	2.0 (5.0)	Hard	90 (10.1)
Single	2.5 (6.25)	Soft	180 (20.3)
Single	2.5 (6.25)	Hard	110 (12.4)
Single	3.0 (7.0)	Soft	210 (23.7)
Single	3.0 (7.0)	Hard	150 (16.9)
Dual	2.0 (5.0)	Soft and Hard	180 (20.3)
Dual	2.5 (6.25)	Soft and Hard	180 (20.3)

Table 1 Drop Test

# 5.4.4 Caster retention

At the conclusion of durability cycling, apply a 5 lbf (22 N) force to each caster in line with the caster stem centerline. The caster shall not separate from the base as a result of the application of a 5-lb. (2.3 kg) load. Minimum pull out force shall be 5 lbf. (22 N) after the caster has completed dynamic requirements in 5.4.1.

# 5.4.5 Conductivity test

The caster shall be tested while supporting a load of 25% of its load capacity. The caster to be tested shall be rolled onto a clean, dry, flat metal plate. The metal plate and the mounting plane (3.5.8) of the caster shall form the electrodes for the test. Any resistance measuring apparatus of a suitable range shall measure the resistance between electrodes. The wheel shall be rotated and measurements taken at five (5) separate points of contact; with the average of these values meeting minimum requirements of 250,000 ohms per wheel (refer to FFC-88-C) and the maximum individual conductivity shall be less than 1,000,000 ohms. All conductive wheels may have a colored dot permanently affixed to the wheel surface, excluding tread, to indicate conductivity, at the manufacturer's discretion

This test does not guarantee that the level of conductivity indicated during the testing will be achieved in application. The manufacturer is not responsible for any change, either loss or gain in conductivity due to, but not limited to, accumulation of dirt, wax, or foreign materials on the wheel.

# 6 Industrial casters – test procedures and acceptance criteria

#### 6.1 Wheel play test

The objective of this test is to determine the initial wheel play (at the beginning of the test sequence) and the final wheel play (at the end of the test sequence).

#### 6.1.1 Test procedure

- **6.1.1.1** The measurements shall be taken with the wheel, bearing, and axle assembled in the fork.
- **6.1.1.2** The fork (3.5.7) of the caster shall be rigidly fixed in a vertical position to ensure that the fork width is maintained and movement of wheel is not impaired.
- **6.1.1.3** The wheel shall then be manually tilted to one side then the opposite side, and the total movement measured (refer to Figure 63).
- **6.1.1.4** The wheel play shall not include any side movement of the wheel on the axle.
- **6.1.1.5** The wheel play value shall be expressed in degrees.



Figure 63: Wheel Play

# 6.1.2 Acceptance criteria

- 6.1.2.1 The measured initial wheel play shall not exceed 3.5°.
- 6.1.2.2 The measured final wheel play shall not exceed 6.5°.

# 6.2 Swivel play test

The objective of this test is to determine the initial swivel play (at the beginning of test sequence) and the final swivel play (at the end of the test sequence).

# 6.2.1 Test procedure

- **6.2.1.1** The measurements shall be taken with the wheel, bearing, and axle assembled in the fork (3.5.7).
- **6.2.1.2** The fork (3.5.7) of the caster shall be rigidly fixed in a vertical position to ensure that the fork width is maintained and movement of swivel is not impaired.
- 6.2.1.3 Place alignment marks on the fixed and swiveling parts of the caster.
- **6.2.1.4** The amplifying bar shall be rigidly attached to the mounting plane (3.5.8), pass through the swivel axis, and for top plate (3.5.9) casters, be parallel to the direction of travel.
- **6.2.1.5** Measure swivel play by moving the amplifying bar in a vertical plane first to the limit of swivel play in one direction and then to the limit of swivel play in the opposite direction (refer to Figure 64).
- **6.2.1.6** Record the vertical distance between swivel play extremes at a point on the amplifying bar at least 7.87 in. (200 mm) from the axis and convert to an angle in degrees.
- **6.2.1.7** Make two measurements each at 90° of swivel rotation from the other. The larger of the two values shall be taken.



Figure 64: Swivel Play

# 6.2.2 Acceptance criteria

- **6.2.2.1** The measured initial swivel play shall not exceed 3° except for light duty.
- **6.2.2.2** The measured final swivel play shall not exceed 6° except for light duty.
- **6.2.2.3** The measured initial swivel play for light duty, as defined by the manufacturer, casters shall not exceed 6°.
- **6.2.2.4** The measured final swivel play for light duty, as defined by the manufacturer, casters shall not exceed 12°.

#### 6.3 Rollability test

The objective of this test is to evaluate the rolling and swiveling performance of a caster at the load capacity. The swiveling portion of this test does not apply to rigid casters.

#### 6.3.1 Test procedure

- **6.3.1.1** Secure the caster(s) to the test fixture.
- **6.3.1.2** Apply the load to the test fixture so it is centered over and supported by the caster(s).
- **6.3.1.3** Attach a measuring device to the test fixture to indicate the force required to move the caster(s).
- **6.3.1.4** Orient the caster(s) so that the wheel(s) are aligned with the direction of travel.
- **6.3.1.5** Apply a gradual force to the fixture in line with the direction of travel while watching the wheel(s) of the caster(s) for rotational movement. Record the peak force (Start-rolling force) required to begin rotation of the caster(s) wheel(s).
- **6.3.1.6** Continue applying force until the caster(s) rolls freely and the measured reading stabilizes. Read the measuring device and record the force (Keep-rolling force) required to maintain the movement of the caster(s).
- 6.3.1.7 Repeat steps 6.3.1.3 through 6.3.1.6 for a minimum of three trials, averaging the results.
- **6.3.1.8** Orient the caster(s) so that the wheel(s) are perpendicular to the direction of travel.
- **6.3.1.9** Apply gradual force to the fixture in line with the direction of travel. Record the peak force (swivel force) as the caster(s) swivels to align with the direction of travel.
- **6.3.1.10** Repeat steps 6.3.1.8 and 6.3.1.9 for a minimum of three trials, averaging the results.

#### 6.3.2 Acceptance criteria

- **6.3.2.1** Caster must roll and swivel smoothly.
- **6.3.2.2** Actual values for the rolling and swivel forces are application specific and can be determined by the customer and the caster supplier.

# 6.4 Conductivity test

The objective of this test is to establish procedures for testing and identifying electro-statically conductive wheels and casters and to establish the maximum electrical resistance of a wheel and/or caster.

#### 6.4.1 Test procedure

- **6.4.1.1** The tread surfaces shall be cleaned and dried by any method that removes wax and dirt, but does not alter the tread surface.
- **6.4.1.2** The test room shall have a mean temperature of 68-72°F (20-22°C) and a relative humidity of less than 80%.
- **6.4.1.3** The caster being tested must be maintained under these conditions for a minimum of 24 hours prior to the test.
- **6.4.1.4** The wheel shall be tested while supporting a load of 25% of its load capacity. The caster to be tested shall be rolled onto a clean, dry, insulated flat steel plate. The metal plate and the mounting plane (3.5.8) of the caster shall form the electrodes for the test. The resistance between electrodes shall be measured by any resistance measuring apparatus of a suitable range. The wheel shall be rotated and measurements taken at 5 separate points of contact, averaging the values.

#### 6.4.2 Acceptance criteria

Electrical resistance categories are defined below:

- **6.4.2.1** Conductive less than 10<sup>5</sup> ohms. All conductive wheels should have a colored dot permanently affixed to the wheel surface, excluding tread, to indicate conductivity, at the manufacturer's discretion.
- **6.4.2.2** Static dissipative less than 10<sup>7</sup> ohms and more than 10<sup>5</sup> ohms.
- **6.4.2.3** Insulation shall be greater than 10<sup>7</sup> ohms.

#### 6.4.3 Limitation

This test does not guarantee that the level of conductivity indicated during the testing will be achieved in application. Changes to the wheel or the accumulation of dirt, wax, or foreign materials on the wheel could impact the wheel's conductivity.

#### 6.5 Wheel brake efficiency test

The objective of this test is to determine the performance of a wheel-braking device.

The brake designs will be tested per the following criteria: tread compression (a braking device that applies a friction force to the tread); hub compression (a braking device that applies a friction force to the hub); positive locking (a braking device that incorporates interlocking features).

#### 6.5.1 Test procedure

**6.5.1.1** Place the caster on a horizontal surface free from visible dirt.

**6.5.1.2** Apply a load equal to the load capacity of the caster to the mounting plane (3.5.8).

- **6.5.1.3** Perform the Rollability Test. Note the start-rolling force.
- **6.5.1.4** Engage the brake.
- **6.5.1.5** Gradually apply the horizontal force (refer to Table 2) plus the start-rolling force from the Rollability Test in line with the running direction of the wheel.
- **6.5.1.6** Maintain the horizontal force for 10 seconds. If during application of the horizontal force the wheel slides, change the surface to a material with a higher coefficient of friction and repeat the test.

**6.5.1.7** Repeat 6.5.1.4, 6.5.1.5, and 6.5.1.6 applying the horizontal force in the opposite direction. With the brake engaged and applying the horizontal force, the wheel must not roll.

#### 6.5.2 Acceptance criteria

The acceptance criteria is outlined in Table 2.

Brake Design	Load Capacity (Percent)
Tread compression	7%
Hub compression	4%
Positive locking	20%

Table 2 Minimum Brake Holding Force

Note: Data for Table 2 based on polyurethane wheels with a durometer of 90 Shore A. (Consult manufacturer on data on other wheel materials).

#### 6.6 Braking and/or locking device fatigue test

This test is to determine if there is any wear and/or permanent deformation that would adversely affect the performance of a braking and/or locking device.

This test is not applicable to braking and/or locking devices based on a threaded mechanism.

#### 6.6.1 Test procedure

- **6.6.1.1** Install the brake and/or locking device into an apparatus that cycles the actuating mechanism through a full "on" and "off" cycle.
- **6.6.1.2** Brake holding power shall be checked before and after the fatigue test (refer to Wheel Brake Efficiency Test).
- **6.6.1.3** Conduct a total of 5,000 test cycles and evaluate the braking and/or locking device at the end of the test procedure.

#### 6.6.2 Acceptance criteria

There shall be no permanent deformation occurring that would adversely affect the performance of the braking and/or locking device.

#### 6.7 Brake engage/disengage force test

This test is to determine the forces required to engage and disengage the brakes.

#### 6.7.1 Test procedure

- **6.7.1.1** Attach brake caster assembly by its normal attachment to a load arm such that the caster assembly is subjected to its rated load.
- **6.7.1.2** Using a calibrated force gage activate the brake to the full "on" position. The force gage shall be applied on the brake in a manner so that the applicable force can be recorded. Gradually apply force to the gage until full brake engagement is achieved.
- **6.7.1.3** Record maximum force to engage brake. Repeat at least three times to obtain an average value.

**6.7.1.4** To measure the force to deactivate the brake, use the force gage in a position noted for the type of brake used. Record the maximum force to deactivate the brake system. Repeat this procedure at least three times to record an average reading.

#### 6.7.2 Acceptance criteria

There is no acceptance criteria associated with this test.

#### 6.8 Static test

The objective of this test is to determine a minimum factor of safety and to determine the load that the caster can support without causing permanent deformation that would impair the function of the caster.

#### 6.8.1 Test procedure

- **6.8.1.1** Apply a compressive load equal to 4 times the load capacity of the individual caster through the mounting plane (3.5.8) for a period of 1 minute.
- **6.8.1.2** Examine the caster for damage or permanent deformation.

#### 6.8.2 Acceptance criteria

The swivel and wheel bearings shall rotate freely and the parts shall be free from defects which would impair caster function.

#### 6.9 Dynamic tests

#### 6.9.1 Dynamic test – industrial casters at or under 2.5 mph (4 kph)

The objective of this test is to establish operational load capacity for industrial casters at or under 2.5 mph (4 kph) and less than 5,000 lb. (2270 kg) load capacity, and to establish the maximum load that can be carried during operation and pass the following test procedure with no functional impairment to the caster.

#### 6.9.1.1 Test procedure

- **6.9.1.1.1** The test running speed will be 2.0 mph (3.2 kph) minimum.
- **6.9.1.1.2** The obstacle orientation shall be one or both of the following:
  - a) The obstacle orientation to caster travel for circular track, vertical position shall be alternately; perpendicular, 45° to the right, and 45° to the left; or
  - b) the obstacle orientation to the caster travel for linear track and circular track (horizontal position) shall be 90°.
- **6.9.1.1.3** The obstacle shall be 2 in. (5 cm) wide steel with a chamfer 45° by one-half the obstacle height on the running edges.
- **6.9.1.1.4** The allowable track configurations are linear track, circular track (horizontal position), and circular track (vertical position) as outlined in Table 3.
- **6.9.1.1.5** The testing protocol is delineated in Table 3.

Test Item	Units	Test Ranges		
Wheel Diameter	in.	0-3	≥3-12	>12
Wheel Diameter	cm	0-7.5	≥7.5-30	>30
Maximum Run Time	min	2	2	2
Maximum Rest Time	min	6	4	2
Run Distance	miles	4	4	4
Run Distance	km	6.4	6.4	6.4
Height of Obstacle	in.	1/16	1/8	3/16
Height of Obstacle	mm	1.59	3.18	4.76
Number of Obstacles	Plate	5000	5000	5000
Number of Obstacles	Stem	500	500	

Table 3Criteria for Dynamic TestingIndustrial Caster Less Than or Equal to 2.5 mph (4 kph)

#### 6.9.1.2 Acceptance criteria

There shall be no functional impairment of the caster.

#### 6.9.2 Dynamic test – industrial caster over 2.5 mph (4 kph)

The objective of this test is to establish operational load capacity for industrial casters at or over 2.5 mph (4 kph) and less than 5,000 lb (2,270 kg) load capacity, and to establish the maximum load that can be carried during operation and pass the following test procedure with no functional impairment to the caster.

#### 6.9.2.1 Test procedure

**6.9.2.1.1** The running speed between obstacles shall be one of the three following configurations based on the caster application.

**Running Speeds** 

3.75 mph	6.25 mph	10.00 mph
(6 kph)	(10 kph)	(16 kph)

- **6.9.2.1.2** The obstacle shall be 2 in. (5 cm) wide steel with a chamfer 45° by one-half the obstacle height on the running edges.
- 6.9.2.1.3 The obstacle orientation to caster travel for linear tracks and circular tracks shall be 90°.
- **6.9.2.1.4** The obstacle cross section shall be rectangular with a chamfer 45° by one-half the obstacle height on the running edges.
- **6.9.2.1.5** The allowable track configurations are linear track, circular track (horizontal position), and circular track (vertical position).
- **6.9.2.1.6** The testing protocol is delineated in Table 4.

Test Item	Units		Test Ranges	5
Wheel Diameter	in.	0-3	≥3-12	>12
Wheel Diameter	cm	0-7.5	≥7.5-30	>30
Maximum Run Time	min	2	2	2
Maximum Rest Time	min	6	4	2
Run Distance	miles	4	4	4
Run Distance	km	6.4	6.4	6.4
Height of Obstacle	in.	1/16	1/8	3/16
Height of Obstacle	mm	1.59	3.18	4.76
Number of Obstacles	Plate	500	5000	7500

Table 4 Criteria for Dynamic Testing Industrial Caster Greater Than 2.5 mph (4 kph)

# 6.9.2.2 Acceptance criteria

There shall be no functional impairment to the caster.

#### 6.10 Side load test

This test is to determine the suitability of the housing/rig strength per the following Test Procedure and Acceptance Criteria.

This Side Load Test applies to rigid casters only.

#### 6.10.1 Test procedure

- 6.10.1.1 Attach the caster to a suitable test fixture.
- 6.10.1.2 Apply a force equal to the load capacity at and parallel to the axle.
- **6.10.1.3** Measure and record the movement of the axle, relative to the mounting plane (3.5.8), at maximum load. Measure the permanent deflection after the load is removed.
- 6.10.1.4 Use an instrument sensitive to 0.001 in. (0.0254 mm) or less.
- **6.10.1.5** The test fixture shall have sufficient rigidity so that its deflection, due to the load applied to the caster, can be ignored.

#### 6.10.2 Acceptance criteria

The maximum movement of the axle relative to the mounting plane (3.5.8) shall not exceed the value of 0.070 times the nominal wheel diameter.

The permanent deflection of the axle to the application and removal of the load shall not exceed the value of 0.030 times the nominal wheel diameter.

#### 6.11 Casters – vertical impact test

The objective of this test is to determine the minimum impact strength of the caster per the following Test Procedure and Acceptance Criteria.

This test applies to rigid and swivel casters with a load rating of less than 5,000 lb. (2,270 kg)

# 6.11.1 Test procedure

- **6.11.1.1** A caster is rigidly mounted wheel up in a test fixture on a solid surface so that a free-falling weight can impact the tread perpendicular to the axis of the wheel.
- 6.11.1.2 The minimum vertical impact force shall be equivalent to the load capacity of the caster dropped 2 in. (5 cm).
- 6.11.1.3 In the case of multiple wheel casters, all wheels shall be impacted simultaneously.

#### 6.11.2 Acceptance criteria

There shall be no functional impairment of the caster.

Note: In the case of multiple wheel casters, all wheels shall be impacted simultaneously.

#### 6.12 Wheels – vertical impact test

The objective of this test is to determine the minimum impact strength of the wheel per the following Test Procedure and Acceptance Criteria.

This test applies to wheels with a load rating of less than 5,000 lb. (2,270 kg)

#### 6.12.1 Test procedure

- **6.12.1.1** The wheel shall be tested while suspended on a special test axle, as defined below.
- **6.12.1.2** The axle diameter shall be 0.005 in. to 0.015 in. (0.13 mm to 0.38 mm) smaller than the diameter of the bore.
- **6.12.1.3** The axle shall be made from drill rod, or equivalent material, and hardened to a minimum of 40 Rockwell C.
- 6.12.1.4 The axle shall be straight, solid, and supported not more than 0.031 in. (0.8 mm) from the hub.
- 6.12.1.5 The minimum vertical impact force shall be equivalent to the load capacity of the wheel dropped 2 in. (5 cm).
- **6.12.1.6** The wheel will be dismounted and examined for defects. Any failure will cause the wheel to be rejected.

#### 6.12.2 Acceptance criteria

There shall be no functional impairment of the wheel.

# 6.13 V-grooved wheel test

The objective of this test is to evaluate the "wedge" effect associated with V-grooved wheels.

# 6.13.1 Test procedure

**6.13.1.1** Attach V-Groove wheel to a suitably rigid test fixture. Make sure that the wheel contacts the round surface of the solid rod in the middle of the "V" as show in Figure 65.



Figure 65: Contact Points for V-Groove Wheel Test

6.13.1.2 The rod size to be used is a function of the width of the groove, as follows:

V-Groove Width	Rod OD
1.75 in (45 mm)	1.25 in (32 mm)
1.375 in (35 mm)	1 in (25 mm)
0.875 in (22 mm)	0.625 in (16 mm)

**6.13.1.3** Gradually apply vertical load through the wheel bore until it reaches two (2) times the rated load of the wheel.

# 6.13.2 Acceptance criteria

There shall be no functional impairment of the wheel.

# 7 Institutional and medical equipment casters – test procedures and acceptance criteria

# 7.1 Wheel play test

The objective of this test is to determine the initial wheel play (at the beginning of the test sequence) and the final wheel play (at the end of the test sequence).

#### 7.1.1 Test procedure

- 7.1.1.1 The measurements shall be taken with the wheel, bearing, and axle assembled in the fork.
- **7.1.1.2** The fork (3.5.7) of the caster shall be rigidly fixed to ensure that the fork width is maintained and the movement of the wheel is not impaired.
- **7.1.1.3** The wheel shall then be manually tilted to one side by pressing on the outer diameter of the wheel until angular movement stops, then the opposite side by pressing on the outer diameter of the wheel until angular movement stops, and the total movement measured (refer to Figure 66).
- 7.1.1.4 The wheel play shall not include any side movement of the wheel on the axle.
- 7.1.1.5 The wheel play value shall be expressed in degrees.



Figure 66: Wheel Play

# 7.1.2 Acceptance criteria

- 7.1.2.1 The measured initial wheel play shall not exceed 3.5°.
- **7.1.2.2** The measured final wheel play shall not exceed 6.5°.

# 7.2 Swivel play test

The objective of this test is to determine the initial swivel play (at the beginning of the test sequence) and the final swivel play (at the end of the test sequence).

# 7.2.1 Test procedure

- **7.2.1.1** The measurements shall be taken with the wheel, bearing, and axle assembled in the fork.
- **7.2.1.2** The fork (3.5.7) of the caster shall be rigidly fixed in a vertical position to ensure that the fork width is maintained and movement of swivel is not impaired.
- 7.2.1.3 Place alignment marks on the fixed and swiveling parts of the caster.
- **7.2.1.4** The amplifying bar shall be rigidly attached to the mounting plane (3.5.8), pass through the swivel axis, and for top plate casters, be parallel to the direction of travel.
- **7.2.1.5** Measure swivel play by moving the amplifying bar in a vertical plane first to the limit of swivel play in one direction and then to the limit of swivel play in the opposite direction (refer to Figure 67).
- **7.2.1.6** Record the vertical distance between swivel play extremes at a point on the amplifying bar at least 7.87 in. (200 mm) from the axis and convert to an angle in degrees.
- **7.2.1.7** Make two measurements each at 90° of swivel rotation from the other. The larger of the two values shall be taken.



Figure 67: Swivel Play

#### 7.2.2 Acceptance criteria

- **7.2.2.1** The measured initial swivel play shall not exceed 3° except for light duty, as defined by the manufacturer, casters.
- **7.2.2.2** The measured final swivel play shall not exceed 6° except for light duty, as defined by the manufacturer, casters.
- **7.2.2.3** The measured initial swivel play for light duty, as defined by the manufacturer, casters shall not exceed 6°.
- **7.2.2.4** The measured final swivel play for light duty, as defined by the manufacturer, casters shall not exceed 12°.

#### 7.3 Rollability test

The objective of this test is to evaluate the rolling and swiveling performance of a caster at the load capacity. The swiveling portion of this test does not apply to rigid casters.

#### 7.3.1 Test procedure

- **7.3.1.1** Secure the caster(s) to the test fixture.
- 7.3.1.2 Apply the load capacity to the test fixture so it is centered over and supported by the caster(s).
- 7.3.1.3 Attach a measuring device to the test fixture to indicate the force required to move the caster(s).
- 7.3.1.4 Orient the caster(s) so that the wheel(s) are aligned with the direction of travel.
- **7.3.1.5** Apply a gradual force to the fixture in line with the direction of travel while watching the wheel(s) of the caster(s) for rotational movement. Record the peak force (Start-rolling force) required to begin rotation of the caster(s) wheel(s).
- **7.3.1.6** Continue applying force until the caster(s) rolls freely and the measured reading stabilizes. Read the measuring device and record the force (Keep-rolling force) required to maintain the movement of the caster(s).
- **7.3.1.7** Repeat steps 7.3.1.3 through 7.3.1.6 for a minimum of three trials; average the results.
- **7.3.1.8** Orient the caster(s) so that the wheel(s) are perpendicular to the direction of travel.

- **7.3.1.9** Apply a gradual force to the fixture in line with the direction of travel. Record the peak force (Swivel force) as the caster(s) swivels to align with the direction of travel.
- **7.3.1.10** Repeat steps 7.3.1.8 and 7.3.1.9 for a minimum of three trials; average the results.

#### 7.3.2 Acceptance criteria

- **7.3.2.1** Caster(s) must roll and swivel smoothly.
- **7.3.2.2** Actual values for the rolling and swivel forces are application specific and can be determined by the customer and the caster supplier.

#### 7.4 Wheel brake efficiency test

The objective of this test is to determine the performance of the wheel braking device.

The brake designs will be tested per the following criteria: tread compression (a braking device that applies a friction force to the tread); hub compression (a braking device that applies a friction force to the hub); positive locking (a braking device that incorporates interlocking features).

#### 7.4.1 Test procedure

- 7.4.1.1 Place the caster on a horizontal surface free from visible dirt.
- 7.4.1.2 Apply a load equal to the load capacity of the caster to the mounting plane (3.5.8).
- **7.4.1.3** Perform the Rollability Test. Note the start-rolling force.
- 7.4.1.4 Engage the brake.
- **7.4.1.5** Gradually apply the horizontal force (refer to Table 5) plus the start-rolling force from the rollability test in line with the running direction of the wheel.
- **7.4.1.6** Maintain the horizontal force for 10 seconds. If during application of the horizontal force the wheel slides, change the surface to a material with a higher coefficient of friction and repeat the test.
- **7.4.1.7** Repeat steps 7.4.1.4 through 7.4.1.6 applying the horizontal force in the opposite direction. With the brake engaged and applying the horizontal force, the wheel must not roll.

#### 7.4.2 Acceptance criteria

The test shall achieve the outcomes as outlined in Table 5.

Brake Design	Percent of Load Capacity
Tread Compression	7%
Hub Compression	4%
Positive Locking	20%
Medical Bed Brake	20%

# Table 5 Minimum Brake Holding Force for Institutional and Medical Equipment Casters

# 7.5 Swivel lock efficiency test

The objective of this test is to determine the performance of the swivel locking device.

This test refers to swivel casters supplied with a braking or locking device acting only on its swiveling mechanism.

#### 7.5.1 Test procedure

- **7.5.1.1** Before and after the dynamic test (operational) the caster shall be placed on a hard, horizontal surface.
- **7.5.1.2** A test load consisting of a dead weight, or other suitable force, shall be applied perpendicular to the mounting plane (3.5.8) of the caster and equal to the load capacity.
- **7.5.1.3** A testing device shall be applied to measure a horizontal force of 20% of the load capacity at 90° to the direction of caster travel.
- **7.5.1.4** If during the application of the horizontal force the wheel slides, change the surface to a material with a high coefficient of friction and repeat the test.

#### 7.5.2 Acceptance criteria

The caster shall not rotate around the swivel axis, and no failures or permanent deformations shall occur that would affect the performance of the swivel lock.

#### 7.6 Braking and/or locking device fatigue test

This test is to determine if there is any wear and/or permanent deformation that would adversely affect the performance of the braking and/or locking device.

This test is not applicable to braking and/or locking devices based on a threaded mechanism.

#### 7.6.1 Test procedure

- **7.6.1.1** Install the brake and/or locking device into an apparatus that cycles the actuating mechanism through a full "on" and "off" cycle.
- **7.6.1.2** Brake holding power shall be checked before and after the fatigue test.
- **7.6.1.2.1** For wheels used for institutional applications, run a minimum of 5,000 brake actuation cycles.
- 7.6.1.2.2 For wheels used for hospital bed, run a minimum of 10,000 brake actuation cycles.

#### 7.6.2 Acceptance criteria

The test is passed if there is no wear and/or permanent deformation, which would adversely affect the performance of the caster.

#### 7.7 Static test

The objective of this test is to establish a minimum factor of safety, and to determine the load the caster can support without causing permanent deformation that would impair the function of the caster.

#### 7.7.1 Test procedure

**7.7.1.1** Apply a compressive load equal to four (4) times the load capacity of the individual caster through the mounting plane (3.5.8) for a period of one minute.

#### **7.7.1.2** Examine the caster for damage or permanent deformation.

#### 7.7.2 Acceptance criteria

There shall be no functional impairment to the caster.

# 7.8 Dynamic test

The objective of this test is to establish operational load capacity and the maximum load that can be carried during operation, and to pass the following test procedure with no functional impairment to the caster.

#### 7.8.1 Test procedure

- **7.8.1.1** The running speed will be 2.0 mph (3.2 km/hr) minimum.
- **7.8.1.2** The obstacle height shall be 3% of wheel diameter to a maximum height of 3/16 in. (4.76 mm).
- **7.8.1.3** The obstacle orientation to caster travel for circular track, vertical position shall be alternately: perpendicular, 45° to the right, and 45° to the left.
- **7.8.1.4** The obstacle orientation to caster travel for linear track and circular track (horizontal position) shall be 90°.
- **7.8.1.5** The obstacle shall be 2 in. (5 cm) wide steel with a chamfer 45° by one-half the obstacle height on the running edges.
- **7.8.1.6** There shall be reverse travel direction at the start of each cycle except circular track vertical position.
- **7.8.1.7** The allowable track configurations are linear track, circular track (horizontal position), and circular track (vertical position).

Test Item	Units	Test Ranges		
Wheel Diameter	in.	0-3	≥3-12	>12
Wheel Diameter	cm	0-7.5	≥7.5-30	>30
Maximum Run Time	min	2	2	2
Maximum Rest Time	min	6	4	2
Run Distance	miles	1.5	1.5	1.5
Run Distance	km	2.4	2.4	2.4
Height of Obstacle	See 7.8.1.2			
Number of Obstacles	Ten times the wheel diameter in mm			

# Table 6Criteria for Dynamic TestingMedical Equipment Casters

#### 7.8.2 Acceptance criteria

There shall be no functional impairment to the caster.

# 7.9 Conductivity test

The objective of this test is to establish procedures for testing and identifying electro-statically conductive wheels and casters, and to establish the maximum surface electrical resistance of a wheel and/or caster.

#### 7.9.1 Test procedure

- **7.9.1.1** The tread surfaces shall be cleaned and dried by any method that removes wax and dirt but does not alter the tread surface.
- **7.9.1.2** The wheel shall be tested while supporting a load of 25% of its load capacity. The caster to be tested shall be rolled onto a clean, dry, flat metal plate. The metal plate and the mounting plane (3.5.8) of the caster shall form the electrodes for the test. The resistance between electrodes shall

be measured by any resistance measuring apparatus of a suitable range. The wheel shall be rotated and measurements taken at five separate points of contact; average the values.

#### 7.9.2 Acceptance criteria

- **7.9.2.1** Conductive less than 10<sup>5</sup> ohm. All conductive wheels may have a colored dot permanently affixed to the wheel surface, excluding tread, to indicate conductive, at the manufacturer's discretion.
- **7.9.2.2** Static dissipative less than 10<sup>7</sup> ohms and more than 10<sup>5</sup> ohms.
- **7.9.2.3** Insulation shall be greater than 10<sup>7</sup> ohms.

#### 7.9.3 Disclaimer

This test does not guarantee that the level of conductivity indicated during the testing will be achieved in application. Changes to the wheel or the accumulation of dirt, wax, or foreign materials on the wheel could impact the wheel's conductivity.

#### 7.10 Casters – vertical impact test

The objective of this test is to determine the minimum impact strength of the caster per the following Test Procedure and Acceptance Criteria. This Vertical Impact Test applies to rigid and swivel casters.

#### 7.10.1 Test procedure

- **7.10.1.1** A caster is rigidly mounted upside down in a test fixture on a solid surface so that a free-falling weight can impact the tread perpendicular to the axis of the wheel.
- **7.10.1.2** The minimum vertical impact force shall be equivalent to the load capacity of the caster dropped 2 in. (5 cm).
- 7.10.1.3 In the case of multiple wheel casters, all wheels shall be impacted simultaneously.

#### 7.10.2 Acceptance criteria

There shall be no functional impairment of the caster.

#### 7.11 Wheels – vertical impact test

The objective of this test is to determine the minimum impact strength of the wheel per the following Test Procedure and Acceptance Criteria. This Vertical Impact Test applies to wheels.

#### 7.11.1 Test procedure

- 7.11.1.1 The wheel shall be tested while suspended on a special test axle, as defined below.
- **7.11.1.2** The axle diameter shall be 0.005 in. to 0.015 in. (0.13 mm to 0.38 mm) smaller than the diameter of the bore.
- **7.11.1.3** The axle shall be made from drill rod, or equivalent material, and hardened to a minimum of 40 Rockwell C.
- 7.11.1.4 The axle shall be straight, solid, and supported not more than 0.031 in. (0.8 mm) from the hub.
- **7.11.1.5** The minimum vertical impact force shall be equivalent to the load capacity of the caster dropped 2 in. (5 cm).
- 7.11.1.6 The wheel will be dismounted and examined for defects.

# 7.11.2 Acceptance criteria

There shall be no functional impairment of the wheel.

# 8 Business machine and shopping cart casters – test procedures and acceptance criteria

#### 8.1 Business machine wheel or caster test

The objective of this test is to simulate ramp and obstacle impacts that could apply to wheels or casters used for business machines.

#### 8.1.1 Ramp impact test procedure

- 8.1.1.1 Secure ramp to the floor.
- 8.1.1.2 Ramp should provide a smooth transition elevating the cart 1 in. (25 mm) above the floor.
- 8.1.1.3 Ramp to maintain its location on the floor as the cart is dropped off the elevated end.
- **8.1.1.4** Push the cart three times over the ramp at a speed of approximately 2.5 mph (4 km/h) over a span of 10 feet while the casters are loaded at 100 percent of their load capacity.

#### 8.1.2 Obstacle impact test procedure

- **8.1.2.1** Using the same ramp apparatus as in 8.1.1, push the cart into the raised (1 in. [25 mm]) end of the ramp at a speed of approximately 2.5 mph (4 km/h).
- **8.1.2.2** Repeat 8.1.2.1 three times.

#### 8.1.3 Acceptance criteria

There shall be no functional impairment of the wheel or caster.

#### 8.2 Shopping cart wheel test

The objective of this test is to determine the durability of shopping cart wheels with a nominal size of 5 in. diameter by 1.25 in. width (125 mm diameter by 32 mm width) under typical conditions found in store applications, including cart retrieval from parking lots.

#### 8.2.1 Test procedure

- **8.2.1.1** The test running speed is 4.4 mph (7.1 km/h).
- 8.2.1.2 Test to be run on a drum with a minimum diameter of 13 in. (33 cm).
- 8.2.1.3 The surface of the drum is to be covered with 80 grit aluminum oxide abrasive cloth.
- **8.2.1.4** Obstacles to include a 0.25 in. (0.64 cm) high steel bar causing one impact per drum revolution, or every 40 in. (102 cm) of travel. The leading edge of the steel bar is to have a 45-degree chamfer with the obstacle oriented to the wheel at 90 degrees.
- 8.2.1.5 Run cycles are 30 seconds on, followed by 30 seconds off.
- **8.2.1.6** A test load of 60 lb. (27 kg) is to be placed directly over the caster stem.
- **8.2.1.7** The drum has a gradual side movement of 1 in. (25 cm) with a rapid spring return with each revolution.
- **8.2.1.8** Wheels are tested with both swivel and rigid fork assemblies.

- 8.2.1.9 The test is to run for a total of 80 hours from start to finish or 40 hours on and 40 hours off.
- **8.2.1.10** The total distance traveled in the test is 176 miles (283 km) with 278,784 impacts.

# 8.2.2 Acceptance criteria

- **8.2.2.1** No more than 40% measured wear on the tread contact area.
- 8.2.2.2 No fracture of any kind around wheel.
- 8.2.2.3 No discernable tread separation.
- 8.2.2.4 Bearing run out and symmetry to be less than 0.050 in. (1.27 mm).

#### 8.3 Shopping cart wheel flat spot test

The objective of this test is to determine if a wheel can slide sideways on a shopping cart and not develop a flat spot on the tread.

#### 8.3.1 Test procedure

- **8.3.1.1** Install wheels on rear rigid horns of a shopping cart equipped with cart lifts, a device that lifts the rear wheels of a cart off the ground when a second cart is rested into the first cart. When nesting carts with cart lifts, the only wheels that contact the ground are the front swivel caster wheels and the last two wheels mounted on the rear of the last shopping cart in the line.
- 8.3.1.2 Nest a total of 10 shopping carts in a line.
- **8.3.1.3** Fix or have someone hold the nose of the front cart in the nested line to keep the front of the first cart in a fixed position.
- **8.3.1.4** Grab the cart handle on the last cart and pivot or swing the carts sideways, rotating the line around a fixed point. Continue pushing the cart sideways until the entire line of carts has rotated 90 degrees from their starting position.
- **8.3.1.5** This pivoting motion will drag the rear wheels sideways and often cause the rear wheels to skid across the pavement.
- **8.3.1.6** The rest of the rigidly mounted wheels will be lifted off the ground by the cart lifts and the swivel caster will pivot and roll as designed.

#### 8.3.2 Acceptance criteria

- **8.3.2.1** If the rear wheel skids and does not rotate, a flat spot on the tread surface may occur. If the rear wheel skids and forms a flat spot, the wheel has failed the test.
- **8.3.2.2** If the rear wheel skids, but continues to slowly rotate, the wear on the tread will be evenly spread around the tread surface. If the rear wheel does not skid and no flat spot is created, the wheel has passed the test.