

[cover]

ANSI B165.1 – 20~~1005~~

Approved American National Standard

[Insert ANSI Logo]

for Power Tools –

Power-Driven Brushing Tools –
Safety Requirements for Design, Care and Use

American National Standards Institute
11 West 42nd Street
New York, New York 10036

[inside front cover]

ANSI®
B165.1 – 20~~1005~~
Revision and redesignation
ANSI/ABMA B165.1 – 1991 (R200~~50~~)

American National Standard
For Power Tools –

Power-Driven Brushing Tools –
Safety Requirements for
Design, Care and Use

Sponsor
American Brush Manufacturers Association

Approved [Insert Approval Date]
American National Standards Institute, Inc.

[page]

AMERICAN NATIONAL STANDARD

Approval of an American National Standard required verification by ANSI that the requirements for due process, consensus, and other criteria for approval have been met by the standards developer.

Consensus is established when, in the judgement of the ANSI Board of Standards Review, substantial agreement has been reached by directly and materially affected interests. Substantial

agreement means much more than a simple majority, but not necessarily unanimity. Consensus requires that all views and objections be considered, and that a concerted effort be made toward their resolution.

The use of American National Standards is completely voluntary; their existence does not in any respect preclude anyone, whether he has approved the standards or not, from manufacturing, marketing, purchasing, or using products, processes, or procedures not conforming to the standards.

The American National Standards Institute does not develop standards and will in no circumstances give an interpretation of any American National Standard. Moreover, no person shall have the right or authority to issue an interpretation of an American National Standard in the name of the American National Standards Institute. Requests for interpretations should be addressed to the secretariat or sponsor whose name appears on the title page of this standard.

CAUTION NOTICE: This American National Standard may be revised or withdrawn at any time. The procedures of the American National Standards Institute require that action be taken periodically to reaffirm, revise, or withdraw this standard. Purchasers of American National Standards may receive current information on all standards by calling or writing the American National Standards Institute.

Published by

American Brush Manufacturers Association
2111 Plum Street, Aurora, IL 60506-3268

Copyright © 20~~10~~05 by American Brush Manufacturers Association
All rights reserved.

No part of this publication may be reproduced in any form, in an electronic retrieval system or otherwise, without prior written permission of the publisher.

Printed in the United States of America

[Insert control number if needed]

[page i]

CONTENTS

Foreword

- 1 Scope
- 2 Normative references
- 3 Definitions
- 4 Design

- 5 General machine conditions
- 6 Mounting of brushes
- 7 Use of brushes
- 8 Speeds
- 9 Handling, storage, and inspection

TABLES

- 1 Minimum spindle (shaft) diameter for brushes of various sizes (in)
- 1a Minimum spindle (shaft) diameter for brushes of various sizes (mm)
- 2 Test factors for speed test of brushes
- 3 Conversion table for brush speeds (Surface speed in feet per minute)
- 3a Conversion table for brush speeds (Surface speed in M per minute)

FIGURES

- 1 Type I, Straight cup brush
- 2 Type II, Flared cup brush
- 3 Type I, Straight cup brush with shank
- 4 Type II, Flared cup brush with shank
- 5 Type III, Wheel or radial brush
- 6 Type III, Wheel or radial brush with shank
- 7 Type IV, End brush
- 8 Type V, Flared end brush
- 9 Type VI, Tabular end brush
- 10 Type VII, Twisted-in wire brush (or tube cleaning brush)
- 11 Type VIII, Strip brush
- 12 Type IX, Class I, cylinder or wide-face brushes mounted by manufacturer
- 13 Type IX, Class 2, expendable or unitized cylinder or wide-face brushes

[page ii]

Foreword (This foreword is not part of American National Standard B165.1 – 201005)

In an endeavor to react with sensitivity to the safety of those associated with power-driven brushes, this standard has as its primary objective the prevention of injuries to those who use them. It would do so by establishing the requirements for the design, care, and use of power-driven brushing tools, excluding those brushing tools constructed with wood, plastic, or composition hubs or cores.

Information contained in this standard is designed to assist machine operators and their supervisors in maintaining and operating all types of brushing equipment, including portable power tools.

The Safety and Standards Committee of the American Brush Manufacturers Association (ABMA) recognizes that it has an obligation to reflect, within this standard, the balanced best

interests of the manufacturers and users. To assist in the interpretation of the requirements of this standard, responsibilities have been assigned to brush manufacturers, brushing machine manufacturers, and brush users. This assignment of responsibilities shows that safety must be a cooperative effort shared equally by each of these segments.

This standard is a revision of American National Standard Safety Requirements of the Design, Care, and Use of Power-Driven Brushing Tools, ANSI B165.1-1991 (R2005~~0~~). The original 1991 standard was developed after it was recognized that there was a need for a safety standard for power-driven brushes. To develop the standard, the Industrial Division of ABMA established a Safety and Standards Committee, which worked cooperatively with the Society of Manufacturing Engineers (SME).

Prior to publication of the 1991 standard, SME canvassed a large number of interested, concerned, and representative industry associations, government agencies, societies, institutions, foundations, and commissions to ensure the development of a consensus. After approval, the Standard was published by SME in 1991 with the co-sponsorship of the ABMA and the cooperative help of the American National Standards Institute (ANSI).

During the past five years, the 2005~~0~~ standard served the best interests of those most affected or influenced by its use. In accordance with the revisions of the American National Standards Institute's five-year periodic review procedure, this Standard has been reviewed, revised, and updated through the Canvass Method. The standard was reaffirmed in 2000 and revised in 2005.

Suggestions for improvement of the standard are welcomed. They should be sent to the American Brush Manufacturers Association, 2111 Plum Street, Aurora, IL 60506-3268.

The following organizations recognized as having an interest in the standardization of power-driven brushing tools were contacted prior to the approval of this standard. Inclusion in this list does not necessarily imply that the organization concurred with the submittal of the proposed standard to ANSI.

Alliance of American Insurers
American Association of Industrial Management
American Dental Association
~~American Electroplaters and Surface Finishers Society~~
American Federation of Labor and Congress of Industrial Organizations (AFL-CIO)
American Foundry Society
American Insurance Association
American Iron and Steel Institute
~~American Occupational Medical Association~~
American Petroleum Institute
American Society for Testing and Materials
American Society of Safety Engineers
American Supply and Machinery Manufacturers Association
American Textile Machinery Association
American Welding Society

Association for Manufacturing Technology
~~Canadian Brush Manufacturers Association~~
Canadian Vehicle Manufacturers Association
Consumer Product Safety Commission
Consumer Testing Laboratories, Inc.
European Brush Manufacturers Association (FEIBP)
~~Factory Mutual Research Corporation~~ FM Global
Gallagher Bassett Services
Gases and Welding Distributors Association
~~Industrial Health Foundation~~
Industrial ~~Risk Insurers~~ Supply Association
International Association of Ironworkers
International Association of Machinists
International Safety Equipment Association
~~Motor Vehicle Manufacturers Association~~
National Association for Surface Refinishing
National Association of Dental Laboratories
National Hardwood Lumber Association
National Restaurant Association
National Safety Council
National Welding Supply Association
Power Tool Institute
Society of Automotive Engineers
Society of Manufacturing Engineers
Society of the Plastics Industry
Triodyne Incorporated
Underwriters Laboratories
Union of Needletrades, Industrial and Textile Employees
United Abrasives Manufacturers Association
United Autoworkers Union
United Brotherhood of Carpenters and Joiners of America
United Steelworkers of America
U.S. Department of Labor – OSHA
U.S. General Services Administration

American National Standard for Power Tools –

Power-Driven Brushing Tools – Safety Requirements for Design, Care, and Use

Standard Requirements

1 Scope

The purpose of this standard is to establish the rules and specifications for safety that apply in the design, use, and care of power-driven brushing tools. It includes specifications for shanks, adapters, flanges, collets, chucks, and safety guards and rules for the proper storage, handling, mounting, and use of brushes. It embraces **aH** configurations of brushing tools whose functional performance is accomplished by power-driven operation. Covered are brushing tools whose brushing elements are made up of ferrous wire, nonferrous wire, plastic, abrasive filaments, vegetable fibers, animal hair, or other materials, and brushes fabricated with any combination of such elements.

Brushing tools whose primary function is vehicle or train washing, carpet sweeping, dental hygiene, floor maintenance, sewer cleaning, street sweeping, and brushing tools manufactured in accordance with other applicable American National Standards are not covered.

2 Normative references

The following standards 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 B7.1, Safety requirements for the use, care, and protection of abrasive wheels

ANSI Z87.1, Practice for occupational and educational eye and face protection

ANSI Z88.2, Practices for respiratory protection

ANSI/UL 60745, Safety standard for portable electric tools

ANSI/UL 987, Safety standard for stationary and fixed electric tools

Z88.2, Practices for respiratory protection

3 Definitions

3.1 General definitions

3.1.1 brush: For brevity in this standard, used interchangeable with “brushing tool,” “power driven brushing tool,” or “power-driven brush.”

3.1.2 shall and should: The word “shall” where used is to be understood as mandatory, and “should” as advisory.

3.1.3 revolutions per minute (rpm): The number of complete turns that a brush makes in one minute.

3.1.4 surface feet per minute (sfpm): The distance in feet traveled by any spot on the peripheral surface of a brush in one minute.

$$\text{sfpm} = \frac{3.1416 \times \text{diameter in inches} \times \text{rpm}}{12}$$

or: 0.262 x diameter in inches x rpm for a very close approximation

3.1.4a surface meters per minute (smpm): The distance in meters traveled by any spot on the peripheral surface of a brush in one minute.

$$\text{smpm} = \frac{3.1416 \times \text{diameter in millimeters} \times \text{rpm}}{1000}$$

or: 0.003 x diameter in millimeters x rpm for a very close approximation

3.1.5 the brush manufacturer: Any individual, partnership, corporation, or other form of enterprise that manufactures or assembles any kind of power-driven brushing tools.

3.1.6 the brush machine or power tool builder:

- Any individual, partnership, corporation, or other form of enterprise that is engaged in the development, or manufacture, or both, or any type of machine or power tool that uses power-driven brushing tools.

- One who converts, changes, or otherwise alters the original design of such machines or power tools.

3.1.7 the user: Any individual, partnership, corporation, or other form of enterprise that uses any kind of power-driven brushing tools or brush machines.

3.1.8 maximum safe free speed (MSFS or max. SFS): Synonymous with maximum safe rpm (free rotation or no-load speed). The maximum speed at which the brush shall be rotated with no work applied (spinning free) to ensure safe operation. All brush manufacturers have the responsibility of determining the MSFS for their products. A recognized criterion for establishing this value for each brush is described in 8.3.

~~3.1.9 operating face width: The width of the face of the brush, measured at operating speed.~~
brush face: The surface of the brush that does the brushing as viewed from the ends of the filaments.

3.1.9.1 face width: The axial dimension at the outside diameter of a brush when it is measured in its static condition.

3.1.9.2 operating face width: The width of the face of the brush, measured at operating speed.

3.1.10 fill or fill material: The filaments that do the brushing in a brush. Fill material can be ferrous or nonferrous wire, abrasive loaded plastic, plastic, composites, vegetable fiber, animal hair, or other materials. Sometimes the fill is a combination of two or more different fill materials, such as wire, tampico, horsehair, plastic, vegetable fiber, and pig bristle.

3.1.10.1 crimped plastic fill material: Synthetic fill material whose linear configuration is not straight or level, but is corrugated in appearance from having been passed through gears or other devices.

3.1.10.2 abrasive loaded plastic fill materials: Synthetic fill material made of plastic monofilaments that have abrasive grit homogeneously dispersed throughout.

3.1.10.3 straight or level plastic fill material: Synthetic fill material that is straight before being used in a brush or before being formed into a tuft or other configuration as part of a brush.

3.1.10.4 vegetable fiber fill material: An end product resulting from the processing of the fibrous part of the leaf or root of various types of plants and trees. Typical fibers are tampico, palmyra, bassine, and palmetto.

3.1.10.5 hair fill material: The hair of any animal except a pig, hog, or boar. Whalebone and feathers are not construed to be hair.

3.1.10.6 bristle fill material: the hair of a pig, hog, or boar.

3.1.11 brush flexibility: The brush's capability to conform to irregular or contoured surfaces are measured by filament deflection.

3.1.12 bonded brushes (also, elastomerically encapsulated brushes): Have elastomer material molded into them unitizing the fill material.

3.1.13 crimped wire: Wire that has been passed through gears or other devices to impart a corrugated appearance ~~configuration similar to a sine waveform~~ to the wire.

3.1.14 straight wire: Wire that was straight before being used in a brush or before being formed into a tuft or other configuration as part of a brush.

3.1.15 twisted tuft or knot: A group of straight wires of equal length that are passed through or around a retaining member, bent into a U-shape, then twisted together to form a single tuft. The helix angle, or angle of twist of a tuft is the angle through which a radial section of a group of wires deflects from its normal position when the wires are subjected to a predetermined twisting torque. The helix angle is a variable, contingent upon the type of wire, the diameter, and the size of the tuft.

3.1.16 shank: Male extension and driving means (usually of an end, wheel, or cup brush) capable of being gripped in a chucking device or collet of proper size.

3.1.17 arbor adapter: Device used to reduce the size of an arbor hole in a brush. Frequently, an adapter is a concentric ring with or without a shoulder.

3.1.18 density: The number of filament ends per given area of brush face.

~~3.1.19 face width: The axial dimension at the outside diameter of a brush when it is measured in its static condition.~~

~~3.1.20 brush face: The surface of the brush that does the brushing as viewed from the ends of the filaments.~~

3.1.19 trim length: Dimension of fill material extending from beyond the retaining member, face plate, or bridle (visible length of filament).

3.1.20 safety guard: Enclosure designed to contain any filaments, or any particles removed by brushing, that might be thrown from the brush or by the brush while it is rotating. Guards shall be placed where necessary, except in the open area of operation to allow access to the work.

3.1.21 safety shield: Fixed or adjustable transparent visor or eye shield that is connected to the brushing machine, which provides additional safety for the operators while permitting them to visually observe the brushing being accomplished. In addition to fixed or adjustable transparent visors or eye shields that are attached to a machine, brush operators and others in the area of the brushing operation shall wear safety goggles, full face shields over safety glasses with side shields, or other forms of personal eye protection as described in ANSI Z87.1.

3.1.22 barrier: any partition, wall, or separate brushing booth that provides protection to the operator and/or other personnel in the area.

3.1.23 arbor hole bushing: Centering device placed in an arbor hole to reduce its size. Tubular bushings are frequently used for this purpose and are used in the same way as adapters without a shoulder.

3.1.24 bridle: Brush component used to control or restrain flare on cup or end brushes.

3.2 Definitions of brush configurations. Elastomerically encapsulated brushes of the following types and classes shall be subject to the same regulations as the base brush.

3.2.1 Type I, straight cup brushes: As shown in Figure 1, type I brushes are brushes with a cup configuration and straight sides that are parallel to the axis of the brush. Dimensions shall include the outside diameter, inside diameter, trim length, overall height, face width, and arbor hole diameter.

- Class 1: crimped wire, abrasive loaded plastic, plastic, fiber, or hair fill material: As shown in Figure 1(a), class 1 brushes with crimped wire, abrasive loaded plastic, or plastic fill material have additional dimensions such as wire or plastic diameter, crimp amplitude, and crimp wave length. Specifications include the appropriate chemical and physical attributes of the fill material. When brushes are furnished with fiber or hair fill material, the type of quality of the material shall be specified.
- Class 2: Twisted tuft or knot fill material: As shown in Figure 1(b), class 2 brushes with a twisted tuft or knot have additional dimensions such as wire diameter and number of rows or tufts. Specifications include the appropriate chemical and physical attributes of the fill material. Helix angle or twist configuration of tufts and length of twist may be described.

3.2.2 Type II, flared cup brushes: As shown in Figure 2, type II brushes are brushes with a cup configuration that have flared cups with the included angle of the cup being a variable depending upon the application. Dimensions shall include outside diameter, inside diameter, trim length, overall heights, face width, and arbor hole diameter.

- Class 1: crimped wire, abrasive loaded plastic, plastic fiber, or hair fill material: As shown in Figure 2(a), class 1 brushes with crimped wire, abrasive loaded plastic or plastic fill material have additional dimensions such as wire or plastic diameter, crimp amplitude, and crimp wave length. Specifications include the appropriate chemical and physical attributes of the fill material. When brushes are furnished with fiber or hair fill material, the type and quality of the material shall be specified.
- Class 2: twisted tuft or knot fill material: As shown in Figure 2(b), class 2 brushes with a twisted tuft or knot have additional dimensions such as wire diameter and number of rows or tufts. Specifications include the appropriate chemical and physical attributes of the fill material. Helix angle or twist configuration of tufts and lengths of twist may be described.

3.2.3 cup brush with shank: Type I straight cup brushes, both class 1 and class 2, can be furnished with a shank as shown in Figures 3(a) and 3(b). Dimensions and specifications shall be the same as in 3.2.1, except arbor hole dimensions are not applicable. Additional dimensions shall include diameter and length of shank.

Type II flared cup brushes, both class 1 and class 2, can be furnished with a shank as shown in Figures 4(a) and 4(b). Dimensions and specifications shall be the same as in 3.2.2, except arbor hole dimensions are not applicable. Additional dimensions shall include diameter and length of shank.

3.2.4 Type III, wheel or radial brush: As shown in Figure 5, type III brushes are circular brushes with a wheel configuration. Dimensions shall include diameter, trim length, face width, and arbor hole dimensions. Radial brushes whose length exceeds their diameter are called cylinder or wide-face brushes (see 3.2.11).

- Class 1: crimped wire, abrasive loaded plastic, plastic, fiber, or hair fill material: As shown in Figure 5(a) class 1 brushes with crimped wire, abrasive loaded plastic, or plastic fill material have additional dimensions such as wire or plastic diameters, crimp amplitude, and crimp wave length. Specifications include appropriate chemical and physical attributes of the fill material. When brushes are furnished with fiber or hair fill material, the type and quality of the material shall be specified.
- Class 2: twisted tuft or knot: As shown in Figure 5(b), class 2 brushes with a twisted tuft or knot have additional dimensions such as wire diameter and number of rows or tufts. Specifications include the appropriate chemical and physical attributes of the fill material. Helix angle or twist configuration of tufts and length of twist may be described.

3.2.5 wheel or radial brush with shank: Type III wheel brushes, both class 1 and class 2, can be furnished with a shank as shown in Figures 6(a) and 6(b). Dimensions and specifications shall be the same as 3.2.4, except that arbor hole dimensions are not applicable. Additional dimensions shall include diameter and length of shank.

3.2.6 Type IV, end brush: As shown in Figure 7, type IV brushes have an end brush configuration with the fill material protruding from one end of the driving component. They generally have a permanently attached shank. The fill material is oriented so that its length is parallel to the axis of the brush. Dimensions shall include face outside diameter, trim length, shank diameter, shank length, overall length, and cup diameter.

- Class 1: end brush with crimped wire, abrasive loaded plastic, plastic, fiber, or hair fill material. There are three styles of class 2 end brushes (see Figure 7(a)). They all have additional dimensions that include wire, abrasive loaded plastic, or plastic diameter, crimp amplitude, and crimp wave length. Specifications include

appropriate chemical and physical attributes of the fill material. When brushes are furnished with fiber or hair fill material, the type and quality of the material shall be specified.

Elastomerically encapsulated brushes of this class shall be subject to the same regulations as the base brush.

- Style A, solid filled end brush: Style A brushes have the cup end filled so that the brush presents a continuous face.
 - Style B, hollow center end brush: Style B brushes are identical to style A brushes in every respect, except that the face has a circular void centrally located on the face of the brush. These brushes have the additional dimensions of face inside diameter.
 - Style C, pilot end brush: Style C brushes are identical to style A brushes in every respect, except that a pilot protrudes from the central part of the face. It has the additional dimensions of the diameter, center length, and radius of the pilot. The chemical and physical properties of pilot material shall be identified.
- Class 2: end brush with twisted tuft or knot, hollow center: Class 2 end brushes (see Figure 7(b)) with a twisted tuft or knot have additional dimensions that include wire diameter, number of tufts, inside diameter, and face outside diameter. Specifications should include appropriate chemical and physical attributes. Helix angle or twist configuration of tufts and length of twist may be described.

3.2.7 Type V, flared end brush: As shown in Figure 8, type V flared end brushes have a self-contained shank. The fill material that protrudes from the retaining cup is flared into a circular pattern, with the filaments being oriented into a radial configuration. Dimensions shall include flared diameter, face width, cup diameter, shank diameter, shank length, overall length, filament diameter, crimp amplitude, and crimp wave length. Specifications include appropriate chemical and physical attributes of wire or other fill materials.

3.2.8 Type VI, tubular end brush: As shown in Figure 9, type VI tubular end brushes are constructed both with and without shank extension. The fill wire, abrasive-loaded plastic, plastic, or other fill material is oriented so that its length is parallel to the axis of the brush. Dimensions shall include outside diameter, trim length, and overall length. The brushes can be filled with either straight or crimped fill material. The diameter of the wire, abrasive-loaded plastic, or plastic fill material shall be specified. If crimped wire, abrasive loaded plastic, or plastic is used, the dimensions of crimp wave length and crimp amplitude shall be specified. Specifications include appropriate chemical and physical attributes of the fill material. When brushes are furnished with fiber or hair fill material, the type and quality of the material shall be specified.

Elastomerically encapsulated brushes of this class shall be subject to the same regulations as the base brush.

If the tubular end brush contains a shank, the diameter and the length of the shank shall be specified.

3.2.9 Type VII, twisted-in wire brush (or tube cleaning brush): As shown in Figure 10, type VII twisted-in wire brushes are made by twisting the fill material between two or more retaining stem wires. This construction places each filament in a radial position in which the total mass of fill material is helical or spiral in configuration. Specifications include type of fill, outside diameter and length of brush part, number of stem wires, stem length, and stem diameter.

Either straight or crimped fill material can be used. The size of the fill material shall be specified. If crimped material is used, the dimensions of crimp wave length and the crimp amplitude shall be specified. Specifications include appropriate chemical and physical attributes of both the fill materials and the stem wire.

If the twisted-in wire brush has a shank or extension affixed to the stem, the diameter of the shank or extensions shall be specified. If the shank is threaded, the size and length of the thread is specified.

Elastomerically encapsulated brushes of this class shall be subject to the same regulations as the base brush.

3.2.10 Type VIII, strip brush: As shown in Figure 11, type VIII strip brushes are manufactured in a continuous strip form and subsequently cut to the required finish length. In addition to their straight configuration (shown in Figure 11), strip brushes may also be helically wound around the outside of an arbor for use as wide-face rotary brushes (see the coil-wound strip in Figures 12 and 13).

Strip brushes are commonly manufactured by roll forming a metal channel and pressing the fill material into the channel in a hairpin configuration. A retaining member runs the entire length of the strip to ensure retention of the fill material.

3.2.11 Type IX, cylinder or wide-face brushes: As shown in Figure 12, type IX cylinder brushes are either directly mounted on reusable arbors by the brush manufacturer or assembled as replacement elements by the user. The mandrel on which the brushes are mounted can be manufactured by either the brush manufacturer, the brush machine builder, or the user. The specifications of the arbor shall be determined by the brush machine builder. The specifications may be modified by the brush manufacturer if the modifications do not preclude the arbor being used in the machine for which it was designed.

The dimensions for the brushes shall include outside diameter, inside diameter, face width, and trim length.

- Class 1: Cylinder or wide-face brushes that are mounted by brush manufacturer: Class 1 brushes are either sectional built-up face brushes or strip brushes. Many modifications of each of them are produced and many are customized for particular

applications of users. Figure 12 shows several types of sectional built-up face and strip cylinder brushes.

The specifications frequently include provisions for brushes in which coolant or other liquids are pumped through the face of the brush.

- Style A, Sectional built-up face:
 - Crimped fill material: Specifications include fill diameter, crimp amplitude, and crimp wave length and appropriate chemical and physical attributes of the fill material.
 - Twisted tuft or knot fill material: Specifications include wire diameter and the number of rows of tufts, helix angle (twist configuration, length of twist, and tuft concentration). Specifications include appropriate chemical and physical attributes of the fill material.
 - Nonmetallic fill material: Specifications shall include type of fill and size of filaments.
- Style B, strip: Strip brushes can be inserted in mounting clips or otherwise anchored on the permanent (reusable) arbors so that the density of the fill can range from very light to very heavy.

Dimensions shall include height and width of metal retaining device, overall height of strip, number of strips, description of the fill material, and helix (spiral) angle of the strip.

- Straight strip brushes with wire or nonmetallic fill material: Straight strip brushes are fastened parallel to the axis of the hub. Specifications include wire diameter, crimp amplitude, crimp wave length, and appropriate chemical and physical properties of the wire fill material, type of material if nonmetallic, and diameter of filaments, where appropriate.
- Helix strip brushes: Helix strip brushes can be assembled in a helically disposed arrangement with the individual strip brushes positioned in a longitudinal direction.
- Coil-wound strip brushes: Strip brushes can be wound circumferentially around the arbor with either a long lead (pitch) or a closely wound lead (pitch) to provide open or dense construction.
- Class 2: Expendable brushes, unitized brushes, or both: Like class 1 brushes, class 2 brushes are either sectional built-up face brushes or strip brushes. These brushes can be manufactured either by factory assembly directly onto the user's shaft or as a cartridge-type unit that is made for later assembly on the user's arbor at the time of need. Examples of these brushes are provided in Figure 13.

- Style A, Sectional built-up face:
 - Crimped fill material: Specifications include type of fill material, fill diameter, crimp amplitude, crimp wave length, and appropriate chemical and physical attributes of fill material.
 - Twisted tuft or knot fill material: Specifications include wire diameter and number of rows of tufts, helix angle (twist configuration), length of twist, tuft concentration, and appropriate chemical and physical attributes of wire fill material.
 - Nonmetallic fill material: Specifications shall include type of fill and size of filaments.
- Style B, strip: Strip brushes can be inserted in mounting clips on the permanent (reusable) arbors or anchored to cartridges that can be mounted on the user's arbors. The mounting method allows a variation in the density of the brush from very light to very heavy. Dimensions shall include height and width of metal retaining device, overall height of strip, number of strips, description of the fill material, and helix angle of the strip, where applicable.
 - Straight strip brushes with wire fill material: Straight strip brushes are fastened parallel to the axis off the hub. Specifications include wire diameter, crimp amplitude, crimp wave length, and appropriate chemical and physical properties of the wire fill material.
 - Straight strip brushes with nonmetallic fill material: In addition to the specifications for straight strip brushes with wire fill material, specifications for strip brushes with nonmetallic fill material also include the type of material and the diameter of filaments, where appropriate.
 - Helix strip brushes: Helix strip brushes can be assembled in a helically disposed arrangement with the individual strip brushes positioned in a longitudinal direction.
 - Coil-wound strip brushes: Strip brushes can be wound circumferentially around the arbor with either a long lead (pitch) or a closely wound lead (pitch) to provide open or dense construction.

4 Design

4.1 Manufacture of brushes

The brush manufacturer shall be responsible for the design of brushes produced and shall apply the principles of strength of materials to ensure that satisfactory materials are utilized and adequate proportions obtained to resist functional forces produced by centrifugal forces or impact.

4.2 Material

All components of the brush shall be of such design as to transmit the driving torque from the spindle to the brush periphery. They shall be constructed in such a manner as to ensure an even distribution of fill material throughout the brush so that good balance can be attained.

Adequate provision for filament retention shall be made. The fill material shall not be burned, broken, or otherwise affected by any assembly operations so as to make it unsafe.

4.3 Marking

When sufficient surface space is available, each brush shall be marked in a permanent manner to show the maximum safe free speed in revolutions per minute; the brush shall also carry the words, "Wear eye protection," when sufficient space is available.

The manufacturer's name or trademark shall also be included. If only the trademark is used, it shall be of such known character that the source of manufacture can be readily determined.

Brush manufacturers may omit their names or trademarks on a brush sold to a distributor or another brush manufacturer whose own name or trademark will appear on the brush. In such cases (known as "private branding"), the brush manufacturer and the private brander shall mutually determine which of them is to do the marking. It shall, however, be the responsibility of the private brander to see that the brush is not transferred to the user without being permanently marked with identifying markings.

4.4 Balance

Brushes that are out of balance set up vibrations that can result in marred work surfaces or machine damage, and that can also cause stress that could result in brush failure. A brush that vibrates in service shall not be used (see 4.1).

4.5 Adapters

If arbor adapters are used in a brush to reduce it to the correct arbor hole size, they shall seat properly in the brush to maintain alignment and balance.

5 General machine conditions

5.1 Machine design and maintenance

It shall be the brush machine builder's responsibility to indicate the maximum rpm of the machine and the size of the brush to be used on the machine based on the requirements for

guarding the machine as described in [ANSI B7.1](#), ANSI/UL 60745 ~~and~~ [or](#) ANSI/UL 987, [as applicable](#).

It shall be the user's responsibility to maintain the machines in safe operating condition.

5.2 Safety Guards

When accommodating brushes, machines and power tools shall be equipped with safety guards as required by 7.7.

5.3 Power

Brushing machines and other power tools on which brushes are used shall be supplied with sufficient power to maintain the rated spindle speed under operating load.

5.4 Exhaust provision

It shall be the user's responsibility to provide adequate ventilation and swarf removal in dry brushing operations. If the user determines that stationary brushing machines used for dry brushing are creating an unsafe amount of dust or other contaminants, then the user shall make provision for connection to an exhaust system.

The exhaust system shall conform to the requirements in ANSI Z88.2 (see 7.9).

5.5 Diameter of spindle

Table 1 shows the minimum diameters of spindles that shall be used for brushes of various sizes. It applies to power tools and machines in which power brushes are not mounted between bearings. Spindles shall be sufficiently heavy and of adequate diameter to perform safely as designed. In some situations, the use of heavier spindles than those listed in Table 1 and 1a as the minimal diameters is desirable.

5.6 Work rests

On single- or double-end pedestal machines used for brushing, work rests shall be used, where applicable, to support the work. They shall be of rigid construction and designed to be adjustable to compensate for brush wear.

Work rests shall be kept adjusted close to the brush with a maximum opening of 1/8 inch (3.175 millimeter) to prevent the work from being jammed between the brush and the work rest, as such jamming may cause failure of the brush or injury to the operator. The work rest shall be securely clamped after each adjustment. The adjustment shall be made with the power source off, with the machine in zero mechanical state, and with no possibility of the brush rotating.

5.7 Limiting brush diameter

Non-portable brushing machines shall be provided with a means of limiting the diameter of the brush to be mounted.

On variable-speed machines, the speed-shifting device shall be connected with an adjustable guard or other diameter-limiting device to prevent the mounting of a brush that might run at higher than the recommended surface speed or rated rpm.

5.8 Direction of machine spindle thread

If brushes are secured by means of a spindle nut, the direction of the thread in relation to the direction of the rotation shall cause the nut to tighten as the spindle revolves.

5.9 Length of machine spindle thread

If brushes are mounted by means of a spindle nut and flanges, two conditions shall be maintained:

- Spindles shall be of sufficient length to allow a full nut mounting;
- The threaded portion shall be sufficient so that the threading will extend well inside the flange but not more than halfway within the arbor hole of the brush.

5.10 Spindle, drive arbor, and arbor hole size

The size of the arbor hole of the brush shall be such that the brush will slip-fit on the drive spindle or drive arbor and shall remain within this fit class under all operating temperatures.

The brush spindle or drive arbor shall not be made larger than the nominal dimension size. The arbor hole of the brush shall be made oversize from the nominal dimension by the brush manufacturer by an amount necessary to ensure a free fit but not a loose fit. When the arbor hole is changed by the manufacturer or user, the recommended tolerances for the arbor hole shall be as follows:

Arbor hole Size (mm) (mm)	Minimum Tolerance (mm)	Maximum Tolerance (mm)	Arbor hole Size (in) (in)	Minimum Tolerance (in)	Maximum Tolerance (in)
Under 15.9	+.025	+.127	Under 5/8	+0.001	+0.005
15.9-50.8	+.025	+.152	5/8 – 2	+0.001	+0.006
50.8-152.4	+.051	+.178	2 – 6	+0.002	+0.007
152.4-304.8	+.076	+.305	6 – 12	+0.003	+0.012

The minimum arbor hole to be used for each class of brush shall be the smallest size offered for sale by the individual brush manufacturer. The minimum size offered shall be compatible with the service conditions for which the brush is intended. Where the user reduces the arbor hole by use of a bushing, or otherwise, the minimum arbor size, the maximum brush face length, and the maximum overhang length shall be in accordance with the recommendations of the brush manufacturer.

The user shall ensure that the size and shape of the arbor hole of the brush will not cause the hole to catch the threads during mounting, which would cause the brush to be eccentric or would prevent proper axial compression and tightening.

5.11 Threaded hole brushes

Machines on which threaded hole brushes are mounted shall be designed with spindles that are threaded so as to allow the brush to be screwed firmly and flat against the back flange, with a minimum engaged thread length of 1X diameter for steel and 2X diameter for aluminum components.

The back of the flange shall be flat, securely fastened, and square to the spindle axis. The fixed back flange shall be of sufficient diameter to ensure proper support to the brush. The direction of the thread shall be such that, in order to be removed, the brush must be turned in the direction of rotation.

If threaded hole brushes have blind holes, the length of the spindle shall be in relationship to the depth of the hole such that the end of the spindle will not touch the bottom of the brush hole.

5.12 Solid shanks for brushes to be used with collets and chucks

These requirements do not apply to shanks on twisted-in wire brushes.

Shank diameters shall be of nominal size, expressed in decimal form with a tolerance not exceeding +0.000 inch --0.005 inch or +0.000 millimeters -0.127 millimeters.

The geometric configuration of shank-type brushes or shank-type arbors shall include generous fillets where the diameters of the parts increase and where stress concentration is likely to occur.

Where extension of a brush shank or arbor shank is needed to obtain additional reach, a special tool extension shall be used. This tool or brush holder shall be of such dimension and geometrical shape as to withstand the brushing pressure used, and avoid deflection that causes vibrations that can become dangerous. The brushes shall be test-run under guarded or shielded conditions for 30 seconds after each mounting or remounting to ensure that they are properly gripped in the chuck or collet.

Shank brushes used with an extension shall only be rotated when contained within the cavity or interior to be abraded. The power shall be turned off and the rotation of the brush stopped before the brush is extracted from the part.

Construction details of user-made or user-selected extension holders shall meet the foregoing requirements.

Brushes used with shanks (types I through VI) are hazardous when chucked with the axis of the brush not parallel to, and concentric with, the axis of the chuck; or not tightened in the chuck

tightly enough to drive it under load; or when used at speeds higher than those recommended by the brush manufacturer; or when the shank has not been inserted to the maximum depth with the minimum overhang.

6 Mounting of brushes

6.1 Inspection

Immediately before mounting, all brushes shall be closely inspected according to 7.2 and 7.4 to make sure they are suitable for use. ~~have not been damaged in transit, storage, or otherwise (see 9.2 and 9.3). the spindle speed of the machines shall be checked before mounting the brush to be certain that it does not exceed the maximum safe free speed marked on the brush or the manufacturer's recommended maximum safe free speed if the brush is of such a size or configuration that marking is not feasible.~~

6.2 Arbor size

Brushes shall fit freely on the spindle and remain free under all brushing conditions. If, however, the spindle is worn or undersize, the brush shall not be mounted, since off-center mounting will cause the brush to be out of balance. If the spindle is oversized, the brush shall not be forced on, since damage to the brush and the machine is almost unavoidable. A sufficient clearance between the arbor hole of the brush and the machine spindle (or adapters) shall be maintained to avoid problems in mounting or removal caused by spindle expansion from temperature change.

To accomplish this, the machine spindle and the brush arbor hole shall be made in accordance with the requirements of 5.10.

6.3 Surface condition

All contact surfaces of brushes, flanges, and adapters shall be flat and free of foreign matter that could result in uneven pressure. Flanges, adapters, and brushes shall be checked periodically to see that they are not distorted or burred so as to cause improper functioning.

6.4 Bushing

When a bushing is used in the arbor hole of the brush, it shall center the brush and ensure that the brush, rather than the bushing, will be gripped by the machine spindle shoulder or machine flange. The driving of the brush shall be accomplished positively through the back or center of the brush rather than through the bushing to ensure proper anchoring and driving of the brush.

6.5 Multiple-section brushes mounted on a common arbor

When more than one brush is mounted on a common arbor, they shall have equal arbor hole diameters. They shall be of a type manufactured for multiple mounting and so designated by the brush manufacturer.

6.6 End nut

The spindle end nut shall be tightened only enough to drive the brush and prevent slippage, and shall be used only if the direction of the threads (right hand or left hand) is such that the nut tends to tighten when rotated and under load.

Spindle end nuts with locking devices such as set screws shall be used under heavy duty conditions or where brush rotation reversal or stopping by brake action is practiced.

6.7 Mounting of shank-type brushes

All shank-type brushes of types I through V, and type VI brushes with and without shank, shall be firmly tightened in a chuck or collet so that no slippage can occur. The shank shall be inserted into the chuck or collet as far as possible on the uniform diameter of the shank with minimum possible overhang of the brush.

6.8 Twisted-in wire brush

Twisted-in wire brushes, type VII, used under power, shall be securely held in a collet, chuck, or similar holding device. The operator shall secure the unit to be brushed and position all guards before starting the brush. The equipment in and the arrangement of the workplace shall ensure rotation of the brush on the true centerline to avoid deflection that may instantly multiply to destructive bending.

6.9 Strip and cylinder brushes

Types VIII and IX brushes shall be affixed firmly to the arbor so that no axial or rotational movement is possible between the brush and the arbor. Keys and keyways that fit shall be used so that no radial movement is possible.

6.10 Flanges

Flanges shall be used when integral face plates are not provided or to ensure safe mounting on the driving shaft or arbor.

Flanges shall be used with brushes where bushings are installed to prevent the axial separation of the brush and the bushing while the brush is in service. The outside diameter of the flanges shall be larger than the bushing and shall actually grip the brush retaining member.

Each pair of flanges shall be of the same size and geometry so that tightening or compressing of the brushes on the arbor will not cause distortion of the retaining members.

Flanges shall be of such size and shape so as not to destructively contact the fill material and cause stress concentration that swiftly leads to long filament breakage.

In multiple-section wide-face brushes, flanges shall contact only the solid brush retaining member that is capable of withstanding the required anchoring compression without distortion. The flanges shall not be of a size or geometry that will contact central web areas or equivalent areas that will bend or distort.

Flanges with either two keys or two keyways, 180° apart, shall be used under heavy duty conditions or with type IX wide-face brushes.

Threaded flanges shall have the correct thread so as to tighten when rotated and under load.

7 Use of brushes

7.1 General

The general rules of this clause shall be equally applicable to all types of classes of brush.

7.2 Inspection

Before mounting, all brushes shall be closely inspected to make sure that they have not been damaged from handling, shipping, storage, or other causes.

If the brushes are wire filled, the wire in the brushes shall be inspected to ensure that no rust or degradation has occurred.

Any rust, discoloration, or other evidence of chemical or physical change in the surface finish of the wire can cause premature failure of the brush by fatigue (see 9.2 and 9.3).

All contact surfaces of brushes, shall be flat and free of foreign matter that could result in uneven pressure. Brushes shall be checked periodically to see that they are not distorted or burred so as to cause improper functioning.

7.3 User's responsibilities

Persons qualified by experience shall be assigned to the mounting, care and inspection of brushes and brush machinery.

The user shall be responsible for the proper handling, storage, and inspection of brushes after receipt and shall maintain them and the equipment on which they are mounted in a safe operating condition at all times.

It shall be the responsibility of the user to fully inform all operating personnel about all of the hazards relating to use of the brush and to instruct them in all aspects of safety in operation of the brush, including but not limited to, correct speeds, proper guarding, protective clothing, and especially, eye protection. All operation and safety instructions shall be followed, as well as common safety practices that will reduce the likelihood or severity of physical injury.

7.4 Brush speed

Before mounting a brush, it shall be determined that the machine speed does not exceed the maximum safe free speed for the brush, as established by the brush manufacturer.

Under no circumstances shall a brush be mounted on a machine whose rpm exceeds the maximum safe free speed recommended for the brush.

7.5 Protective clothing and equipment

Appropriate protective clothing and equipment required for any brushing operation will vary with the size, nature, and location of the work. The user shall specify the special protective clothing and equipment required for all personnel in the area of each brushing operation.

Use of protective eye equipment shall be required for all brush operators and others in the area of the brushing operation, and face equipment shall also be required where there is a reasonable possibility of injury that can be prevented by such equipment. In such cases, users shall make conveniently available a type of protector recommended for the work to be performed, and personnel shall use such protection. No unprotected personnel shall be purposely subjected to a hazardous environmental condition, and the user shall supply adequate eye protection equipment to all personnel working or coming into the hazardous area.

~~Design, construction, testing, and use of devices for eye and face protection shall be in accordance with ANSI Z87.1.~~

Brush operators and others in the area of the brushing operation shall wear safety goggles, full face shields over safety glasses with side shields, or other forms of personal eye protection designed, constructed and tested in accordance with ANSI Z87.1.

7.6 Additional enclosure (or barrier)

Because the nature of many brushing operations requires personnel, other than the operator, to be in proximity to the brushing area, these personnel shall be protected by an enclosure that isolates the operation from the remaining work area, or equivalent (see 3.1.30). (See also 7.5 for the required protective clothing and equipment for such personnel.)

All personnel who have occasion to come into the enclosed brushing area (even if not in close proximity to the brushing operation) shall wear suitable eye protection as well as protective clothing and equipment described in 7.5.

7.7 Guarding of brushes

Because rotating brushes ~~can be~~ ~~are inherently~~ hazardous, the operator, as well as other workers in proximity to the brushing station, shall be protected by safety guards meeting the requirements of the applicable brush machine (power tool) standard (see 5.1).

Rotating brushes shall be used only on machines provided with safety guards, however, safety guards are not required for brushes used for recessed work, brushes used for internal work and brushes used on hand-held power tools, i.e. drills and grinders, unless recommended by the power tool manufacturer in the instruction manual provided with the tool.

7.7.1 Safety guards on pedestal grinders, bench and floor stands

Machines known as bench or pedestal grinders shall comply with ANSI B7.1 [and/or UL 987](#).

7.7.2 Safety guards on automated equipment

The safety guards on automated brushing equipment shall be designed to admit the work to be brushed, but not the hands or other parts of the operator's body. It may be constructed so as to be adjustable for brushes of different sizes, but, once adjusted, it shall be affixed in that position.

7.7.3 Interlocking safety guards

[When the brushing machine is not covered by an end use product safety standard \(ref. 5.1\),](#)
[I](#)nterlocking safety guards shall be considered if fixed safety guards are not practical.

7.7.4 Safety guards for exposed brush protrusions

Brushes with exposed collars, couplings, cams, clutches, flywheels, shaft ends, or other protrusions shall have such protrusions guarded with a brush safety guard or the equivalent.

7.7.5 User's responsibility

It shall be the user's responsibility to maintain the safety guards, safety shields, and barriers in good condition. The user shall also make provision for the safety and protection of the personnel in the operating area (see 7.3, 7.5, and 7.6).

7.8 Starting the brush

Before starting the machine on which a brush is mounted, all required personal eye protection and personal protective equipment, safety guards, barriers, or enclosures shall be in place. The machine shall be jogged to ensure that it is in readiness for use and that the brush is fastened securely and is concentric with the axis of rotation.

After the machine has been turned on, the brush shall be run at operating speed for at least one minute before applying work to dislodge loose particles. During this time, no one shall stand in front of or in line with the brush.

7.9 Exhaust provision

On dry brushing operations, where brushes are mounted on floor stands, pedestals, benches, or special purpose machines, the user shall determine the need for connection to an exhaust system.

If it is determined that there is such a need, then provision shall be made for connection to an exhaust system that conforms to the minimum exhaust provisions recommended by OSHA Safety Code 1910.94 (see E7.9). The exhaust system shall be in operation before the brushing is started (see 5.4).

8 Speeds

8.1 Safe free speeds

Safe free speed is any speed below the maximum safe free speed. The maximum safe free speed for each brush shall be established by the brush manufacturer (see 3.1.8).

8.2 Maximum speeds

It shall be the user's responsibility not to exceed the maximum safe free speed established by the manufacturer.

It shall be recognized that the maximum safe free speed is not necessarily the most efficient brushing speed. Better results are frequently obtained at speeds lower than maximum safe free speeds.

8.3 Speed test (brush manufacturer's responsibility)

The speed test described in this subclause is based on the fact that centrifugal forces caused by excessive speeds can permit the working stresses to which the brush is subjected to exceed the strength of its materials. The purpose of the test is to ensure the existence of a factor of safety to minimize this risk. Representative brushes shall be speed-tested in accordance with Table 2. These brushes shall be speed-tested for a period of 30 seconds at the test speed, determined by multiplying the maximum safe free speed of the brushes by the minimum test factor as shown in the Table. However, the ultimate destruction speed shall be greater than the minimum test speed. If any representative brushes burst during the test at speeds shown in Table 2, the entire lot shall be rejected.

This speed test is not designed to determine the mechanical properties of the brush, which should already have been determined by the brush manufacturer (see 4.1 and E4.1).

In some cases, the shape, size, construction, or conditions of use of the brush make the speed test inapplicable or misleading. Examples of brushes that need not be speed-tested include twisted-in wire brushes and strip brushes.

The brush manufacturer shall, upon demand, furnish certification showing that representative brushes have been speed-tested and have passed the test satisfactorily.

8.4 Brush machine and power tool builder's responsibility

All brushes classified for use under Table 2 of this standard shall be used on machines and power tools designed and equipped in accordance with all of the requirements for guards and other general machine conditions described in clauses 5 and 9.

8.5 User's responsibility

All brushes shall be used in conformance with instruction given in clauses 4 to 9.

8.5.1 Speed check of machines and power tools

The speed of the spindle on brush machines or power tools shall be checked frequently with suitable instruments, by competent personnel employed by the user, to make sure that the speed is correct for the type and size of brushes used.

8.5.2 Speed adjustment control

If the speed of the machine spindle is adjustable, the speed adjustment shall be under the supervision and control of competent and authorized personnel only.

Such personnel shall use care in determining that the speed at any present moment conforms to and does not exceed the peripheral speeds (in surface feet/meters per minute), the rated MSFS as established for a new brush, or both (see Table 3 and 3a).

8.6 Requirements for special speeds

On effectively guarded, fully protected machines, brushes used on special applications at speeds higher than those recommended by the brush manufacturer shall be used only in accordance with 8.6.1 through 8.6.3, as applicable.

If the brush manufacturer allows a special speed, the special speed shall replace the safe free speed for that brush. In this case, the brush manufacturer shall determine the special maximum safe free speed.

8.6.1 The brush manufacturer's responsibility

It shall be the manufacturer's responsibility to speed-test brushes required for special speeds and to identify them as being able to operate safely at special speeds.

If it is impractical to mark the brush, then the box or package in which it is wrapped shall contain the required markings, either on the outside of the package or printed on an insert placed inside of the package.

The brush manufacturer shall make certain that the brushes are of adequate strength, have been speed-tested in accordance with Table 2, and bear the brush manufacturer's approval of the higher speed.

8.6.2 The brush machine builder's responsibility

The brush machine builder shall make certain at the time of manufacture that the machine has been designed and guarded in such a manner as to protect the operator from injury.

It shall be the brush machine builder's responsibility to design and construct those machine components that are concerned with the safe operation of the brushing machine at the speed and for the type of operation for which the machine is intended.

Particular attention shall be given to the design of the safety guards and the mounting spindle of the brush.

If an existing machine is to be adapted for use at a special speed, the brush machine builder shall check all component parts of the brushing machine and, if necessary, modify or adjust all component parts prior to operation at the special speed.

When the operation is beyond the conditions for which the guards were designed, the brush machine builder shall ensure by test or calculation that the guards are capable of withstanding the special speeds, and, if necessary, replace, modify, or adjust the guards prior to operating at the special speed.

When the operating conditions are determined as exceeding the capacity of the machine and guards, the brush machine builder shall ensure by test or calculation the specifications for adequate replacement of the mechanical mechanisms and apparatus.

8.6.3 The user's responsibility

Before operating the machine at a special speed, the machine user shall make certain that the machine is operated with approved safety guards as defined in 7.7, and that the machine is maintained in a satisfactory condition, as defined in clause 5.

After receipt of the brushes, it shall be the user's responsibility to provide safe handling, storage, and inspection for the brushes designed for special needs in accordance with clause 4 and to maintain his brushing equipment in a safe operating condition at all times. Rules of safe operation of this equipment submitted by the brush machine builder shall be observed as well as those rules specified in other clauses of this standard. A user shall not operate a brush designed for special needs faster than the special maximum safe free speed established by the brush manufacturer.

When an existing machine is altered by the user to operate at special speeds, the user shall assume all of the responsibility of a machine builder as outlined in this Standard.

The user shall fully inform all operating personnel that only brushes identified for operation at special speeds shall be used, and that, at no time, shall the special maximum safe free speed be exceeded.

9 Handling, storage, and inspection

9.1 Handling

All power-driven brushing tools can be damaged by improper handling. The following rules shall always be observed:

- 1) Handle brushes carefully so that the fill material is not disoriented or bent, potentially causing an imbalanced condition to exist.
- 2) Do not rest any brush on its face, or place any object on the face of the brush that might tend to distort the face or become imbedded in the face.
- 3) Do not roll cylinder brushes (barrel fashion) or wheel brushes (hoop fashion).
- 4) When handling cylinder brushes with a sling, do not use a sling that is narrow enough to become impressed into the face of the brush.
- 5) Do not open packaged brushes until they are to be used or unless they need to be inspected. After inspection, repackage them in a manner that will ensure the same amount of protection as the original package.
- 6) During handling, keep all brushes boxed or covered so that foreign matter cannot accumulate and become lodged in the face of the brush.
- 7) Place brushes carefully on shelves or in boxes, bins, or other compartments so that brushes do not rest in any way that could cause a distorted condition.

9.2 Storage

Suitable racks, bins, drawers, or boxes shall be provided by the user to store the various types of brushes used. Storage recommendations of the brush manufacturer shall be followed. Brushes shall not be stored where they will be subjected to:

- Exposure to high humidity, heat, water, UV or other liquids that might induce deterioration or dimensional changes to the filaments or other brush components. (This deterioration includes rusting of ferrous metals and rotting, checking, or warping of wood and degrading of plastics.)
- Exposure to acids or fumes from acids that might induce deterioration to the filaments or other brush components.
- Any temperature low enough to cause condensation on the brushes when they are moved from storage to an area of higher temperature or humidity or both, or low enough to cause embrittlement or other deterioration to the filaments or other brush components.
- Storage that causes bent or distorted brush components.
- Damaged brush filaments from sliding the brushes across abrasive or rough surface.
- Exposure to the accumulation of foreign matter that may become attached to or lodged in any of the brush components.

9.3 Inspection

Immediately after being unpacked or uncrated, all brushes shall be closely inspected to make sure that they have not been damaged from handling, shipping, or other causes. If examination discloses damage, the brushes shall not be used.

A typical defect that might be encountered on wire brushes is ~~oxidation~~ rust (oxidation), discoloration in the surface finish caused by exposure to environmental conditions.

EXPLANATORY INFORMATION

(Not part of American National Standard ANSI B165.1-201005)

E1 Scope

It is the intent of this standard to cover all power-driven brushes, of any size, any materials, any construction or any configuration except those specifically excluded under the scope. Brushes with wood or synthetic hubs and cores, which have overall appearances very similar to power brushes of this standard, have been excluded because the parameter of construction and use differ fundamentally from brushes covered in this standard. Other brushes excluded in this standard have been omitted because of significant differences in construction, dimension, service conditions or application.

E2 Bibliography (informative)

ANSI/NFPA 91-2004, Blower and exhaust systems

ANSI/UL 154 CAN/ULC-5503-2005, Safety standard for carbon-dioxide fire extinguishers

OSHA SAFETY CODE 1910.94

OSHA Title 29, Chap. 17, Part 1910.94(b)

E3.1.3 Revolutions per minute

Although machine spindle speeds are usually indicated in revolutions per minute (rpm), and motor name plate speeds invariably are described in terms of the number of revolutions the motor will produce in one minute, brush speeds often classified in surface feet per minute (sfpm) or surface meters per minute (smpm). It is, therefore, essential to know the difference between how they are measured and what those measurements mean.

E3.1.4 Surface feet per minute

When the diameter of a brush is indicated in inches, it is necessary to divide by 12 the result of multiplying the diameter by rpm by pi (3.1416). An example of this equation follows for a brush 12 inches in diameter turning at 1000 rpm:

$$\frac{3.1416 \times 12 \times 1000}{12} = 3141.6 \text{ sfpm}$$

This measurement is also referred to as “circumferential speed.”

E3.1.4a Surface meters per minute

When the diameter of a brush is indicated in millimeters, it is necessary to divide by 1000 the result of multiplying the diameter by rpm by pi (3.1416). An example of this equation follows for a brush 305 millimeters in diameter turning at 1000 rpm:

$$\frac{3.1416 \times 305 \times 1000}{1000} = 957.6 \text{ smpm}$$

This measurement is also referred to as “circumferential speed.”

E3.1.9 Operating face width

The width of a wheel brush rotating at operational speeds frequently is different from the width or face of the same brush in a stationary condition. The face width of brush filaments in a static brush is usually wider than the same assembly of filaments at point of attachment. When rotating at operational speeds, centrifugal force orientates all filaments into a radial, more compact configuration that substantially reduces any lateral displacement. As a result, the mass of filaments are nearly the same width at the periphery as they are at the point of attachment.

E3.1.10.1 Crimped plastic fill material

The configuration of crimped plastic fill materials is similar to that of crimped wire (see 3.1.13).

E3.1.10.6 Bristle fill material

The term “bristle,” when used in relationship to brushes, is restricted and limited to the hair of the swine exclusively and should not be used to describe any other filaments.

E3.1.11 Brush flexibility

The quality of a brush that determines resiliency or stiffness is measured in terms of resistance to the bending of filaments. This physical characteristic of flexibility, sometimes referred to as “modulus of elasticity (stiffness),” can be varied in a number of ways. Primary ways are as follows:

- Change modulus of elasticity of the fill materials, which varies for different materials. For example: steel, brass, hair, nylon.
- Increase or decrease the diameter of fill material. For example: 0.020 inch (.508 millimeters) steel wire is stiffer than 0.005 inch (.127 millimeters) steel wire of same analysis.
- Increase or decrease the trim length of the fill material. For example: A steel wire filament that is 0.010 inch (.254 millimeters) in diameter and 1 inch (25.4 millimeters) long is stiffer than a similar steel wire filament that is 0.010 inch (.254 millimeters) in diameter and 4 inches (101.6 millimeters) long.
- Increase or decrease the speed of rotation. For example: The faster a brush is rotated, the stiffer it becomes because of the influence of centrifugal force.
- Change the construction of the brush. For example: Filaments of wire twisted together as in a knotted or twisted tuft brush are stiffer than those in a crimped wire brush. In the knot or twisted tuft construction, the filaments being twisted together act as a family of filaments, while in a crimped wire brush, they act more independently of other filaments.
- Increase or decrease the number of brushing points per square unit of brush face. This changes the brush flexibility through wire packing, load division, or both; accordingly, flexibility increases as density decreases and, conversely, less capability to conform to the surface being brushed will result as density increases.
- Encapsulating, coating, or treating the brushes makes them less flexible than the brushes without encapsulation, coating, or treatment.

E3.1.13 Crimped wire

[insert Illustration 1]

E3.1.17 Arbor adapter

Adapter should be designed so that, when tightened, the adapter shoulder is bearing against the brush. Brushes using adapters without a shoulder are tightened to bear against the brush. When used in pairs, adapters should be of the same or proper shape to avoid cross-bending pressures and distortion of the brush; and should be of sufficient rigidity to resist distortion from mounting pressure.

Adapters can be distorted by excessive tightening, or burred by dropping; therefore, they should be checked periodically.

In some brush operations in which wheel slippage may be a problem, it may be necessary to key or otherwise securely fasten the adapters to the spindle.

E3.1.24 Barrier

Such protection takes the form of an enclosure that isolates the operation from the remaining work area. Barriers can be either fixed or adjustable enclosures and are usually not connected with the brushing machine.

E3.2.11 (1) Class 1: Cylinder or wide-face brushes that are mounted by brush manufacturer

Aside from the two primary styles mentioned in this clause, there are many other types of class 1 cylinder or wide-face brushes. Since they are too numerous to describe in this standard, only the two most common styles have been included.

E3.2.11 (2) Class 2: Expendable brushes, unitized brushes, or both

Aside from the two primary styles mentioned in this clause, there are many other types of class 2 cylinder or wide-face brushes. Since they are too numerous to describe in this standard, only the two most common styles have been included.

[insert Figure 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13]

E4.1 Manufacture of brushes

Brush manufacturers know the basic construction of their own brushes best, are knowledgeable about the nature and characteristics of their products, and are aware of the use and functions for which they were designed.

The design parameters for a brush used to defuzz a peach is obviously different from those for brushes used to descale steel. Brush manufacturers recognize the need for different strength requirements for various applications and consequently design their brushes so that the working stresses encountered in a given application will not exceed the strength of the material of the brushes.

E4.2 Material

The design of the brush and the material from which it is made should be established with operator safety in mind.

E4.3 Marking

The required type of marking will leave permanent as well as legible admonishments and identification on the brush.

The markings can be etched, molded in, or die stamped.

Marking or labeling the packages of smaller items (under 1 inch or 2.54 cm) is desirable and would meet the requirements of this standard.

The American Brush Manufacturers Association (ABMA) shall maintain a list of manufacturers and their marks. Each manufacturer will submit a current sample of their mark or their marks to ABMA and advise them of any future changes.

All packages containing brushes should have a summary of the safety precautions given in this standard printed either on each package or on a card or slip placed inside the package. When placed inside the package, the package (or label on the package) shall be marked **Warning: Read, study and understand all warnings and operating instructions on the enclosed safety slip and those provided with your power tool before using this brush.**

All brushes delivered to end users shall be accompanied with a copy of the summary safety precautions as available from the ABMA or packaged with the product. See Illustration 2 for the recommended text for this summary.

If a copy of the summary safety precautions is unavailable, please contact ABMA info@abma.org or visit the website <http://www.abma.org> to receive a copy.

[Insert Illustration 2]

E4.4 Balance

Unlike many other rotating tools, it would be difficult for the user to bring back into true balance.

E5.1 Machine design and maintenance

It is important that the maintenance of the machine be such that the equipment remains in the same condition as originally furnished. If the brush machine builder has provided special operating instructions or placed warning signs on the machine, these, as well as the general operating rules, should be followed to ensure a safe brushing operation.

E5.3 Power

Deterioration of operating conditions caused by insufficient power causes many problems. For example, reduction in brush speed, even while holding normal brush pressures, will cause a substantial decrease in cutting rate and efficiency. If pressure is increased to compensate for low brush speed, excessive heat and wear will be encountered, resulting in decreased cutting rate and

efficiency. Reduced speed means reduced centrifugal force and a consequent reduction in the stiffness of the brush fill material. This loss of stiffness permits normal brush pressures to overflex the filament and induce premature fatigue. Over-stressed filaments that undergo fatigue will break off, creating a hazard. Adequate power will avoid this hazard.

E5.4 Exhaust provision

The adequacy of the ventilation should be determined by following the minimum exhaust provisions shown in E7.9 and E7.9a. If connection of an exhaust system is not possible, then personal respirators for operators and others in the area should be provided.

E5.5 Diameter of spindle

Spindles are also referred to as “shafts” or “arbors” depending upon the nomenclature used by the various brush machine builders. Their usual machine design generally conforms to the minimum shaft diameters shown in Table 1 and 1a. It is not uncommon for the user to unwittingly circumvent Tables 1 and 1a by requests for brushes larger in diameter than were originally intended for the machine. Since such a change in the outside diameter would also likely require a larger shaft hole and arbor, this is a dangerous practice that is to be avoided.

E5.6 Work rests

Measurement of the 1/8-inch (3.175 millimeter) clearance can be accomplished from the nominal face condition while the brush is stationary. Jogging of the brush will establish whether further adjustment is necessary to help compensate for a normal expansion.

E5.7 Limiting brush diameter

The safety guard can be used to limit the diameter of the brush on single-spindle or multiple-spindle machines. On variable-speed machines, a positive mechanical or manual regulation check should be maintained to avoid overspeeding another or full-sized brush after a worn brush has been removed.

In general, brush driving equipment that is stationary (fixed position) should use brushes with an outside diameter of 6 inches (152.4 millimeters) or larger. Portable tools (6000 rpm maximum) should use brushes 6 inches (152.4 millimeters) or smaller, whereas hand-held power tools and tools that rotate the brushes at speeds higher than 6000 rpm should use brushes 3 inches (76.2 millimeters) or smaller.

E5.8 Direction of machine spindle thread

In many types of equipment, such as double-end pedestal or bench grinders on which brushes are used, a right-hand thread is found on one end and a left-hand thread on the opposite end. If such machines are disassembled for maintenance or repair, it is essential that they be reassembled correctly in relation to the direction of threads.

The following rule will assist in determining the proper relationship: “To remove the nut, it must be turned in the direction in which the spindle revolves when the brush is in operation.”

E5.9 Length of machine spindle thread

These two conditions are necessary to avoid the geometry of the threads from inadvertently preventing proper axial compressions and anchoring of brush rolls, especially when made up of sections.

E5.10 Spindle, drive arbor, and arbor hole size

It is important that the diameter of the spindle no be larger than the nominal size (usually +0.000 inch, -0.002 inch or +0.000 millimeter, -0.051 millimeter) and that the hole in the brush be kept suitable oversized to ensure a free fit under all operating conditions. This clearance is needed for expansion of the spindle caused by the heat of the operation.

E5.11 Threaded hole brushes

If the flange that is in contact with the threaded portion of the brush is not flat or is recessed, it would be possible, by tightening the brush on the arbor, to distort the brush or even pull the threaded bushing out of the brush.

If the spindle stops quickly when power is shut off, the energy stored in the spinning brush may cause it to unscrew from the arbor and “spin off” the machine.

To help prevent “spinning off,” the thread on the machine arbor should be maintained in good condition and the brush should be held in contact with the work piece until the brush has stopped rotating.

When applicable, a spindle end nut should be used to preclude “spinning off.”

E5.12 Solid shanks for brushes to be used with collets and chucks

The method of manufacture of twisted-in wire brushes precludes holding shank diameters to the same tolerances as those for shanks made by turning, forming, cold-heading, or machining techniques.

E6.2 Arbor size

Arbors that become undersize from wear, and brush adapters that become oversize from wear, can cause the machine to become imbalanced. The user should maintain both the arbor and the brush adapter diameters to preclude this problem.

E6.3 Surface condition

Excessive tightening can cause serious distortion of the flanges. They should be inspected prior to each mounting to ascertain that they are still flat and suitable for proper seating in the brush.

E6.4 Bushing

If the bushing is wider than the brush in which it is used, it will interfere with proper tightening of the flanges against the brush. The power required to drive a brush is transferred through the flanges. If this power is partially or completely transferred through the bushing, failure of the brush could occur.

E6.5 Multiple-section brushes mounted on a common arbor

In some applications of wide-face brushes that consist of sections in a stacked array mounted on a common arbor, slippage of the whole unit of brushes or of sections within the group of brushes may be a problem. In these cases, it may be necessary to key or otherwise securely fasten each of the individual brushes to the arbor.

E6.6 End nut

If multiple screw flanges are used, they shall be tightened uniformly to prevent springing of the flanges and to ensure even distribution of mounting pressure over the entire surface of the flanges.

E6.7 Mounting of shank-type brushes

Since the overhang of a shank-type brush is a factor in determining the maximum allowable operating speed, care should be taken to ensure that the overhang conforms to the limitations that have been established for the brush.

E6.8 Twisted-in wire brushes

The shank of a twisted-in wire brush, because of its basic construction, is not inherently as strong as the shank on most other brushes. Therefore, it is even more important that the overhang not be excessive, and that other conditions of use avoid the load application and speed of rotation that will cause the shank to deflect, and therefore bend, instantly resulting in total destruction of the brush and creating an unsafe condition for the operator.

E6.9 Strip and cylinder brushes

Arbors that accommodate cylinder brushes usually are fitted with two keyways at 180° from each other. If one key is omitted, an imbalanced condition is created because of loss of weight. If only one key is used, the cylinder brush should be rebalanced before use to compensate for the asymmetrical weight distribution.

E6.10 Flanges

The major stresses produced in an operating brush tend to combine and become greatest at the true retaining member of the brush structure. It is therefore important that stresses due to mounting and driving do not unnecessarily concentrate on the same part of the brush.

Flanges should be identical in diameter and radial bearing surface to avoid cross-bending pressures and stresses in the brush.

Flanges should be large enough in diameter to approximately equal the size of the face plate of a brush, or the size that a face plate would be, if used, so that the brush retaining members (the wire anchoring means) is safely enclosed between the face plates. Such ample flanges ensure positive driving of the brush.

E7.2 Inspection

The first inspection should be made on the original shipping container. If there is visible evidence of damage to the container, special attention should be given to an immediate inspection of the brushes.

It is important that all brushes be inspected carefully before mounting.

E7.3 User's responsibility

On new and future products developed by the brush manufacturer and the brush machine builder, the standard recommended practices may apply. However, the user should review and understand provided information, operating manuals, safety data sheets, and recommended practices to ensure safe operation.

E7.4 Brush speed

Based on the structural strength of the brush, a maximum safe free speed is established. This speed should not be exceeded. Faster speeds may be expected to exceed the ability of the brush to withstand the stresses that are developed by the rotational forces and tangential forces combined.

E7.5 Protective clothing and equipment

In normal power brushing operations, the material being removed (such as burrs, scale, dirt, weld slag, or other residue) will fly off the brush with considerable force along with the brush filaments, which break off due to fatigue.

The potential of serious injury exists for both the brush operator and others in the work area (possibly 50 feet (15.2 meters) or more from the brush). Before rotating the brush, the operator and others in the area are required to wear protective eye equipment and face equipment, such as safety goggles or full face shields, worn over safety glasses with side shields, along with protective clothing capable of resisting a force of 23 Newtons with a penetration of 0.5 inch (1.3 centimeters).

E7.6 Additional enclosure (or barrier)

Any wall, partitions, or booths serving as an enclosure or barrier for a brushing operation should be identified as such.

It is the user's responsibility to identify the additional enclosure or barrier.

E7.7 Guarding of brushes

Exceptions to the use of safety guards are based on the impossibility of using smaller brushes with conventional guards in place. In these cases, the work often forms a guard. Eye and face protection is particularly important when using smaller brushes.

E7.7.1 Safety guards on pedestal grinders, bench and floor stands

Maximum guard openings are based on the fact that the line of flight of particles from the part being brushed, swarf, and the residue from the brush will be tangential in the direction of rotation of the brush. The maximum exposure angle should not be exceeded.

E7.7.2 Safety guards on automated equipment

Frequently, in automated brushing equipment fitted with large cylinder brushes, the machine is made in such a manner as to totally enclose the brush. This type of guarding restrains bursting brushes, swarf produced by brushing, and brush filaments that have broken off, and also prevents access to the brush while it is rotating.

E7.7.3 Interlocking safety guards

When end product safety standards for brushing machines are available, such as those mentioned in 5.1, compliance with, their guarding requirements provides sufficient protection to the users of brushes.

An interlocking safety guard is not fixed, and may be operated or removed as the operation requires. However, due to an electrical or mechanical interlocking connection with the operating mechanism, the operation of the machine is prevented until the guard is returned to an operating position and the operator can no longer reach the point of danger.

After mounting a brush, care should be taken to see that the electrical or mechanical mechanisms actuated by an open safety guard are operational. This should be ascertained before starting the brush.

E7.8 Starting the brush

This provides for the safety of the operator and others, should there have been damage to the brush, foreign matter accumulated in the brush, or malfunction of the machine from any cause.

E7.9 Exhaust provision

According to OSHA Safety Code 1910.94 under section 2, Table G5, the recommended minimum exhaust volume that should be used is as follows:

Wheel diameter (in)	Minimum width (in)	Exhaust volume (ft ³ /min)
to 9	2	300
9 to 16	3	500
16 to 19	4	610

To determine the need for an exhaust system, see OSHA Title 29, Chap. 17, Part 1910.94 (b) Table G, or ANSI/NFPA 91.

E7.9a Exhaust provision

According to OSHA Safety Code 1910.94 under section 2, Table G5, the recommended minimum exhaust volume that should be used is as follow:

Wheel diameter (mm)	Minimum width (mm)	Exhaust volume (m ³ /min)
to 229	50.8	8.5
229 to 406	76.2	14.2
406 to 483	101.6	17.3

To determine the need for an exhaust system, see OSHA Title 29, Chap. 17, Part 1910.94 (b) Table G, or ANSI/NFPA 91.

E8.2 Maximum speeds

The maximum safe free speed as determined by the manufacturer is dependent upon the brush shape and strength. The strength of a brush may be defined as the ability of the brush to withstand rotational stress under no-load conditions.

E8.3 Speed test (brush manufacturer's responsibility)

The test speed subjects a brush to significantly greater forces than does the maximum safe free speed. This test establishes an adequate factor of safety, provided the brushes are used in accordance with safe practices outlined in this standard, and have not been altered, damaged, or abused.

The speed test does not justify operation of the brush at higher than the maximum safe free speed established by the brush manufacturer. The maximum safe free speed should never be exceeded, because the additional test strength covers other normal brushing stresses encountered in use.

No simple formula can possibly accommodate all of the various types and proportions of brushes, and, at the same time, provide a uniform factor of safety for each. Because of the considerations of safety, such a formula would penalize the better constructions to accommodate the weaker designs.

E8.4 Brush machine and power tool builder's responsibility

The reference to other applicable sections and regulations are important. All designers of brush machinery should be familiar with them. Their proper application has a direct relationship to the safe use of brushes.

E8.5 User's responsibility

The references to other applicable sections and regulations are important. All users of brushes should be familiar with them. Their proper application has a direct relationship to the safe use of brushes.

E8.5.1 Speed check of machines and power tools

It is of special importance that the portable air grinders be checked to be sure that proper air pressure is maintained and that the machine governor mechanism is clean, in good operating condition, and functioning properly. This reference to air tools is not intended to downplay the necessity for a regular check of the speed on all types of brushing machines. Various types of speed-testing equipment are available, including tachometers, revolution counters, speed indicators, and stroboscopic mechanisms. A record of such speed checks should be maintained by the user.

E8.5.2 Speed adjustment control

Certain machines are designed with adjustable speeds to permit maintenance of efficient surface speeds by increasing the speed of the brush spindle to compensate for the reduction of the brush diameter.

E8.6 Requirements for special speeds

When brushes are used at speeds in excess of standard speeds, extra precautions should be observed to ensure safe operation of the brush.

E8.6.1 The brush manufacturer's responsibility

The brush manufacturer should do the testing necessary to establish an adequate factor of speed. The brush should be marked to indicate that it has been approved for high speed under specific conditions of use.

E8.6.2 The brush machine builder's responsibility

The machine builder should be sure that the components of the machine, such as the spindle, bearings, guards, flanges, and horsepower, are adequate for the brushing operation.

The brush machine builder and brush manufacturer should cooperate to make sure that a brush of adequate strength can be manufactured for the operation; design and composition limitations might preclude making a brush for operation at special speeds.

The brush machine builder should decide upon the fitness of the machine for the proposed operation. If it becomes necessary or desirable to convert, change, or alter the machine from the design or purpose for which it was originally made by the builder, the components involved with the use of the brush should be designed in accordance with the appropriate classes of this standard.

E8.6.3 The user's responsibility

The user should establish that all guards on the machine are adequate for the higher speed and should also maintain the machine in good condition for continuing safety.

The special speed as determined by the manufacturer is dependent on the size, geometry, and material of the brush. In this instance, strength is defined as the ability of the brush to withstand rotational stress.

E9.1 Handling

Poor handling of brushes can contribute to unsafe conditions in a number of ways. Brushes damaged as in 9.1(1), (2), (4), and (7) that have filaments permanently deformed prior to use must be expected to adversely affect brush life, fill stiffness, surface finish, and safety itself, since stress concentrations at bends will occur and higher stresses will result when non-radially disposed wires lengthen upon contact with the work surface. This condition can also create imbalance in a brush that could result in extensive damage to the machine and the operator. Brushes that are out of balance and that cannot be balanced by adding or removing weight should be removed from the machine (see 4.2).

Poor handling creates safety hazards in another way, as shown in 9.1(2), (3), (5), and (6). In each instance, there is a possibility of foreign objects being lodged in the face of the brush. These imbedded objects can be thrown from the brush at great velocities when the brush attains operating speed.

E9.2 Storage

Any type of storage that permits the formation of rust on the filament wires or any corrosion to the filament surfaces, or that permits such mechanisms as hydrogen embrittlement to occur, can cause premature failure of the material. The failure is caused by corrosion fatigue. When corrosion occurs, there is a general roughening and etching effect that influences the fatigue strength of the material. Pitting caused by corrosion can result in a reduced cross section, thus increasing the magnitude of the stress unit. Even when only a few spots on the material are involved, the results are harmful, since the first crack will almost always occur prematurely in the corroded area, and, once started, will propagate through the unaffected area.

When corrosion is occurring during in-service use due to the repeated stressing that occurs naturally in a brush during use, the deleterious effect of corrosion fatigue is even greater. Special care should be exercised to avoid this condition because filaments that have been fatigued by corrosion present a hazard since they break off in use in long lengths and fly from the brush at dangerous velocities.

If rust is visible, corrosion has already become extensive enough to reduce the fatigue life of the brush.

If it is unavoidable that wire brushes will be stored in an environment that may contribute to corrosion, some protective steps can be taken. The brushes can be wrapped in protective paper before being placed in the storage area. This practice, or some equivalent, can preclude much difficulty assignable to corrosion resulting from storage conditions that are less than desirable.

Some users who have less than adequate storage facilities compensate for the lack by better planning of deliveries. They schedule deliveries so that brushes do not remain long in poor storage conditions.

Brushes can also be damaged by sliding them over an abrasive surface. This abrades the fill material and consequently creates a new fatigue hazard. Such fatigue failures frequently start from even superficial-appearing surface scratches, markings, and discontinuities that develop into fatigue cracks. As the material flexes in use, these cracks, even though initially microscopic in size, propagate and material breaks off. This flying material poses a safety hazard for the brush operator and those in the area.

E9.3 Inspection

The first inspection should be made on the box, crate, or container in which the brushes were shipped. If there is any evidence of damage to the container, special care should be used in the inspection of brushes.

Other examples of damage caused by poor handling or packaging are bent or dented shafts or arbors and disarranged working faces that preclude safe balance and concentric operation. Other typical defects may include any or all defects as a result of incorrect handling (see 9.1) and storage (see 9.2).

Table 1 – Minimum spindle (shaft) diameter for brushes of various sizes (in).

Maximum Diameter of Wheel Brush (inches)	Maximum Face Width (inches)	Minimum Outside Diameter of Spindle (Shaft) (inches)
2	3/4	1/4
3	3/4	1/4
3 (Heavy duty)	1	3/8
4	1	3/8
6	1 1/4	1/2
8	1 1/4	5/8
10	2	3/4
12	3	1
14	3	1 1/4
15	3	2
16	3	2

NOTE – These diameters are based upon the wheel brush being mounted next to the supported end of the bearing, rather than the unsupported end, in order to minimize overhang.

Table 1a – Minimum spindle (shaft) diameter for brushes of various sizes (mm).

Maximum Outside Diameter of Wheel Brush (mm)	Maximum Face Width (mm)	Maximum Outside Diameter of Spindle (Shaft) (mm)
50	20	6mm
75	20	6mm
75HD	25	10mm
100	25	10mm
150	32	13mm
200	32	16mm
250	50	19mm
300	75	25mm
350	75	32mm
380	75	32mm
400	75	50mm

NOTE – These diameters are based upon the wheel brush being mounted next to the supported end of the bearing, rather than the unsupported end, in order to minimize overhang.

Table 2 – Test factors for speed test of brushes

Class of brush	Minimum test factor ¹
Type I. Straight cup brush	
Class 1. Crimped	1.2
Class 2. Twisted tuft or knot	1.2
Type II. Flared cup brush	
Class 1. Crimped	1.2
Class 2. Twisted tuft or knot	1.2
Type I. Straight cup brush with shank	
Class 1. Crimped	1.2
Class 2. Twisted tuft or knot	1.2
Type II. Flared cup brush with shank	
Class 1. Crimped	1.2
Class 2. Twisted tuft or knot	1.2
Type III. Wheel or radial brush	
Diameter	
Class 1. Crimped	
2 to 6 inches – 101.6 to 152.4 millimeters	1.2
6 to 9 inches – 152.4 to 228.6 millimeters	1.3
9 inches and over – 228.6 millimeters and over	1.5
Class 2. Twisted tuft or knot	
2 to 6 inches – 101.6 to 152.4 millimeters	1.2
6 to 9 inches – 152.4 to 228.6 millimeters	1.3
9 inches and over – 228.6 millimeters and over	1.5
Type III. Wheel or radial brush with shank	
Class 1. Crimped	1.2
Class 2. Twisted tuft or knot	1.2
Type IV. End brush	
Class 1. Crimped	
Style A. Solid fill	1.2
Style B. Hollow center	1.2
Style C. Pilot end	1.2
Class 2. Twisted tuft or knot, Hollow center	1.2
Type V. Flared end brush	1.2
Type VI. Tubular end brush	
With shank	1.2
Without shank	1.2
Type VII. Twisted-in wire brush	No Speed Test
Type VIII. Strip brush	No Speed Test
Type XI. Cylinder brush	
Class 1. Mounted by manufacturer	
Style A. Crimped, or twisted tuft or knot	No Speed Test
Style B. Straight, helix, or coil-wound strip	No Speed Test
Class 2. Expendable or unitized	
Style A. Crimped, or twisted tuft or knot	No Speed Test
Style B. Straight, helix, or coil-wound strip	No Speed Test

¹ Maximum safe free speed shall be multiplied by this test factor to establish the minimum speed at which brushes are to be tested by the brush manufacturer.

Table 3 – Conversion table for brush speeds (Surface speed in feet per minute)

r/min*	Brush diameter (inches)								
	2	3	4	6	8	10	12	15	16
200	105	157	209	314	419	524	629	785	838
400	209	314	419	628	838	1047	1257	1571	1676
600	314	471	628	942	1257	1571	1885	2356	2513
800	419	628	838	1257	1676	2094	2513	3142	3351
1000	524	785	1047	1571	2094	2618	3142	3927	4189
1200	628	942	1257	1885	2513	3142	3770	4712	5027
1400	633	1100	1466	2199	2932	3665	4398	5498	5864
1600	838	1257	1676	2513	3351	4189	5027	6283	6702
1800	942	1414	1885	2827	3770	4712	5655	7069	7540
2000	1047	1571	2094	3142	4189	5236	6283	7858	8378
2200	1152	1728	2304	3456	4608	5760	6912	8639	9215
2400	1257	1885	2513	3770	5027	6283	7540	9425	10053
2600	1361	2042	2723	4084	5445	6807	8168	10210	10891
2800	1466	2199	2932	4398	5864	7330	8796	10996	11729
3000	1571	2356	3142	4712	6283	7854	9425	11781	12566
3200	1676	2513	3351	5027	6702	8378	10053	12566	13404
3400	1780	2670	3560	5341	7121	8901	10681	13352	14242
3600	1885	2827	3770	5657	7540	9425	11310	14137	15080
3800	1990	2985	3979	5969	7959	9948	11938	14923	15917
4000	2094	3142	4189	6283	8378	10472	12566	15708	16755
4400	2304	3456	4608	6912	9215	11519	13823	17279	18431
4800	2513	3770	5027	7540	10053	12566	15080	18850	20106
5200	2723	4084	5445	8168	10891	13674	16336	20420	21782
5600	2932	4398	5864	8796	11729	14661	17593	21991	23457
6000	3142	4712	6283	9425	12566	15708	18850	23562	25133
6500	3403	5105	6807	10210	13614	17017	20420	25525	27227
7000	3665	5498	7330	10996	14661	18326	21991	27499	29322
7500	3927	5890	7854	11781	15708	19635	23562	29452	31416
8000	4189	6283	8378	12566	16755	20944	25133	31416	-
8500	4451	6676	8901	13352	17802	22253	26704	-	-
9000	4712	7069	9425	14137	18850	23562	28274	-	-
9500	4974	7461	9948	14923	19897	24871	29845	-	-
10000	5236	7854	10472	15708	20944	26180	31416	-	-
11000	5756	8639	11519	17279	23038	28798	-	-	-

12000	6283	9425	12566	18850	25133	31413	-	-	-
13000	6807	10210	13614	20420	27727	-	-	-	-
14000	7330	10996	14661	21991	29322	-	-	-	-
15000	7854	11781	15708	23562	31416	-	-	-	-
16000	8377	12566	16755	25133	-	-	-	-	-
17000	8901	13352	17802	26704	-	-	-	-	-
18000	9425	14137	18850	28274	-	-	-	-	-
19000	9948	14923	19897	29845	-	-	-	-	-
20000	10472	15708	20945	31416	-	-	-	-	-
22000	11519	17279	23038	-	-	-	-	-	-
24000	12566	18850	25133	-	-	-	-	-	-
26000	13614	20420	27227	-	-	-	-	-	-
28000	14661	21991	29322	-	-	-	-	-	-
30000	15708	23562	31416	-	-	-	-	-	-

* Revolutions per minute for various diameters of brushes to give surface speed in feet per minute as indicated.

NOTE – “Centrifugal force,” the force that tends to rupture a given brush when overspeeding, increases as the square of the velocity of that wheel brush. For example, the centrifugal force in a brush running at 5500 surface feet per minute is 49% greater than in the same brush running at 4500 surface feet per minute, although the speed is actually only 22% greater.

Table 3a – Conversion table for brush speeds (Surface speed in M per minute)

r/min*	Brush diameter (millimeters)								
	51	76	102	152	203	254	305	381	406
200	32	78	64	96	128	160	192	239	255
400	64	96	128	192	255	319	383	479	511
600	96	144	192	287	383	479	585	718	766
800	128	192	255	383	511	638	766	958	1021
1000	160	239	319	479	638	798	958	1197	1277
1200	192	287	383	575	766	958	1149	1436	1532
1400	223	335	447	670	894	1117	1341	1676	1787
1600	255	383	511	766	1021	1277	1532	1915	2043
1800	287	431	575	862	1149	1436	1724	2155	2298
2000	319	479	638	958	1277	1596	1915	2394	2553
2200	351	527	702	1053	1404	1756	2107	2633	2809
2400	383	575	766	1149	1532	1915	2298	2873	3064
2600	415	622	830	1245	1660	2075	2490	3112	3320

2800	447	670	894	1341	1787	2234	2681	3351	3585
3000	479	718	958	1436	1915	2394	2873	3591	3830
3200	511	766	1021	1532	2043	2553	3064	3830	4086
3400	543	814	1085	1628	2170	2713	3256	4070	4341
3600	575	862	1149	1724	2298	2873	3447	4309	4596
3800	606	910	1213	1819	2426	3032	3639	4548	4852
4000	638	958	1277	1915	2553	3192	3830	4788	5107
4400	702	1053	1404	2107	2809	3511	4213	5267	5618
4800	766	1149	1532	2298	3064	3830	4596	5745	6128
5200	830	1245	1660	2490	3320	4149	4979	6224	6639
5600	894	1341	1787	2681	3575	4469	5362	6703	7150
6000	958	1436	1915	2873	3830	4788	5745	7182	7660
6500	1037	1556	2075	3112	4149	5187	6224	7780	8299
7000	1117	1676	2234	3351	4469	5586	6703	8379	8937
7500	1197	1795	2394	3591	4788	5985	7182	8977	9576
8000	1277	1915	2553	3830	5107	6384	7660	9576	-
8500	1357	2035	2713	4070	5426	6783	8139	-	-
9000	1436	2155	2873	4309	5745	7182	8618	-	-
9500	1516	2274	3032	4548	6065	7581	9097	-	-
10000	1596	2394	3192	4788	6384	7980	9576	-	-
11000	1756	2633	3511	5267	7022	8778	-	-	-
12000	1915	2873	3830	5745	7660	9576	-	-	-
13000	2075	3112	4149	6224	8299	-	-	-	-
14000	2234	3351	4469	6703	8937	-	-	-	-
15000	2394	3591	4788	7182	9576	-	-	-	-
16000	2553	3830	5107	7660	-	-	-	-	-
17000	2713	4070	5426	8439	-	-	-	-	-
18000	2873	4309	5745	8618	-	-	-	-	-
19000	3032	4548	6065	9097	-	-	-	-	-
20000	3192	4788	6384	9576	-	-	-	-	-
22000	3511	5267	7022	-	-	-	-	-	-
24000	3830	5745	7660	-	-	-	-	-	-
26000	4149	6224	8299	-	-	-	-	-	-
28000	4469	6703	8937	-	-	-	-	-	-
30000	4788	7182	9576	-	-	-	-	-	-

* Revolutions per minute for various diameters of brushes to give surface speed in meters per minute as indicated.

| NOTE – “Centrifugal force,” the force that tends to rupture a given brush when overspeeding, increases as the square of the velocity of that wheel brush. For example, the centrifugal force in a brush running at 5500 surface meters per minute is 49% greater than in the same brush running at 4500 surface meters per minute, although the speed is actually only 22% greater.

NOTES

- 1 The illustration shows a single-plane crimped filament; however, dual-plane crimped filaments are more commonly used.
- 2 F =Full wave length; $F/2$ = Half wave length; D = Filament diameter; A =Crimp amplitude

Illustration 1 – Single-plane crimped filament

Illustration 2 – Summary – Power brush Safety Requirements

WARNING: Failure to observe safety precautions may result in injury.

Summary - Power Brush Safety Requirements

Eye Protection Safety goggles: Safety goggles or full face shields worn over safety glasses with side shields must be worn by all operators and others in the area of power brush operations. Comply with the requirements of ANSI Z87.1, “Occupational and Education Eye and Face Protection.”

Guards: Keep all machine guards in place.

Speeds: Observe all speed restrictions indicated on the brushes, containers, labels, or printed in pertinent literature. “MSFS” means Maximum Safe Free Speed (rpm) – spinning free with no work applied. For reasons of safety, the “MSFS” should not be exceeded under any circumstances.

Safety standards: Comply with the Safety Standards of the Industrial Division of the American Brush Manufacturers Association and American National Standards ANSI B165.1, “Safety Requirements – Power Brushes”.

Protective equipment: Use appropriate protective clothing and equipment (such as gloves, respirators, etc.) where possibility of injury exists that can be prevented by such clothing or equipment.

Figure 1 – Type I, Straight cup brush

- a) Class 1, Crimped wire, abrasive-loaded plastic, plastic, fiber, or hair fill material
- b) Class 2, Twisted tuft or knot fill material

Figure 2 – Type II, Flared cup brush

- a) Class 1, Crimped wire, abrasive-loaded plastic, plastic, fiber, or hair fill material
- b) Class 2, Twisted tuft or knot fill material

Figure 3 – Type I, Straight cup brush with shank

- a) Class 1, Crimped wire, abrasive-loaded plastic, plastic, fiber, or hair fill material
- b) Class 2, Twisted tuft or knot fill material

Figure 4 – Type II, Flared cup brush with shank

- a) Class 1, Crimped wire, abrasive-loaded plastic, plastic, fiber, or hair fill material
- b) Class 2, Twisted tuft or knot fill material

Figure 5 – Type III, Wheel or radial brush

- a) Class 1, Crimped wire, abrasive-loaded plastic, plastic, fiber, or hair fill material
- b) Class 2, Twisted tuft or knot fill material

Figure 6 – Type III, Wheel or radial brush with shank

Style A, Solid filled end brush

Style B, Hollow center end brush

Style C, Pilot end brush

- a) Class 1, Crimped wire, abrasive-loaded plastic, plastic, fiber, hollow center, or hair fill material
- b) Class 2, Twisted tuft or knot fill material, hollow center

Figure 7 – Type IV, End brush

- a) Bottom view
- b) Side view

Figure 8 – Type V, Flared end brush

- a) Without shank
- b) With shank

Figure 9 – Type VI, Tubular end brush

- a) Double stem construction
- b) Single stem construction
- c) Double stem, single spiral

- d) Single stem, single spiral
- e) Double stem, double spiral

Figure 10 – Type VII, Twisted-in wire brush (or tube cleaning brush)

Figure 11 – Type VIII, Strip brush

Crimped wire, abrasive-loaded plastic, plastic, fiber or hair fill material

| Twisted tuft or knot fill material

a) Style A, Sectional built-up face

Straight strip

Helix strip

Coil-wound strip

b) Style B, Strip face

Figure 12 – Type IX, Class 1, Cylinder or wide-face brushes mounted by manufacturer

Crimped wire, abrasive-loaded plastic, plastic, fiber or hair fill material

Twisted tuft or knot fill material

a) Style A, Sectional built-up face

Straight strip

Helix strip

Coil-wound strip

b) Style B, Strip face

Figure 13 – Type IX, Class 2, Expendable or unitized cylinder or wide-face brushes