



The American Society of  
Mechanical Engineers

# SAFETY STANDARD FOR MECHANICAL POWER TRANSMISSION APPARATUS

AN AMERICAN NATIONAL STANDARD

**ASME B15.1-2000**  
(Revision of ASME B15.1-1996)



The American Society of  
Mechanical Engineers

A N A M E R I C A N N A T I O N A L S T A N D A R D

# **SAFETY STANDARD FOR MECHANICAL POWER TRANSMISSION APPARATUS**

**ASME B15.1-2000**  
(Revision of ASME B15.1-1998)

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## FOREWORD

(00)

This Safety Standard for mechanical power transmission apparatus is the most universally applicable standard concerned with safeguarding mechanical equipment. Few machines can operate without some mechanical linkage somewhere between the energy source and point of operation.

The first edition of the B15 standard was approved in 1927 and reaffirmed in 1935. The second edition was approved in the 1953 revision and reaffirmed in 1958. The third edition was approved in 1972 and had departed from the format of previous editions in defining specific areas of responsibility and in establishing performance requirements for the types of safeguarding that apply to mechanical power transmission apparatus. The fourth edition was approved in 1984 followed by an Addenda which was approved in 1986. The fifth edition was approved in 1992 followed by an (a) Addenda that was approved in 1994 and (b) Addenda that was approved in 1995. The sixth edition was approved in 1996 followed by an (a) Addenda that was approved in 1997 and (b) Addenda that was approved in 1998.

The purpose of this Standard is to provide guidance for minimizing the likelihood that people will incur injury when in the proximity of mechanical power transmission apparatus. This Standard is presented in a "performance" mode rather than a "specification" mode to encourage the appropriate use of ingenuity and imagination in achieving a maximum degree of safeguarding. As written, the left-hand column contains the requirements of this Standard, and the right-hand column (Explanatory Information) contains advisory and illustrative material which is not a part of this Standard, but supports the intent of this Standard.

Good judgment is encouraged to be used with this Standard in matters where safe practice and safety are involved. It is also recognized that an appropriate attitude regarding safety can be beneficial in the avoidance of injury.

Safety codes and standards are intended to enhance public health and safety. Revisions result from Committee consideration of factors such as technological advances, new data, and changing environmental and industry needs. Revisions do not imply that previous editions were inadequate.

The values stated within the Standard are in both SI and U.S. customary units, with the latter placed in parentheses. These units are noninterchangeable and, depending on the country, as well as industry preferences, the user will determine which values are to be regarded as the standard.

This Standard was approved by the B15 Committee and by the ASME and designated as an American National Standard by the American National Standard Institute on August 2, 2000.

## **ASME COMMITTEE B15 Safety Standard for Mechanical Power Transmission Apparatus**

(The following is the roster of the Committee at the time of approval of this Standard.)

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## ASME B15.1-2000 SUMMARY OF CHANGES

The 2000 edition of ASME B15.1 includes changes, revisions, and corrections introduced in B15.1a-1997 and B15.1b-1998 as well as those listed below, identified on the pages by a margin note, (00).

<i>Page</i>	<i>Location</i>	<i>Change</i>
iii	Foreword	Second paragraph revised
5	E3.2.1(a)	Both cross-references revised
	E3.2.3(c)	Both cross-references revised
9	Fig. E12	Fig. 12 redesignated as Fig. E12
10	Table E1	Fig. 13 redesignated as Table E1
11	Fig. E13	Fig. 14 redesignated as Fig. E13

### **SPECIAL NOTE:**

The interpretations to ASME B15.1 are included as a separate section for the user's convenience.

# SAFETY STANDARD FOR MECHANICAL POWER TRANSMISSION APPARATUS

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## Standard Requirements

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## Explanatory Notes<sup>1</sup>

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### 1 SCOPE, PURPOSE, APPLICATION, AND EFFECTIVE DATE

#### 1.1 Scope

The requirements of this Standard apply to any source of hazard to people from the operation of mechanical power transmission apparatus on machines, equipment, or systems that are stationary in their use, other than the point of operation. This Standard applies to the sources of mechanical power, and also to pulleys, gears, and other mechanical components used to transmit power to the point of operation. Where other standards take precedence by specific reference to power transmission apparatus, this B15.1 Standard shall not apply.

#### 1.2 Purpose

The purpose of this Standard is to provide requirements for use in developing effective safeguarding methods to protect people from injury due to inadvertent contact with mechanical power transmission apparatus. When specific safeguarding methods are listed, they are based on sound safety practices; however, alternatives that provide equivalent protection are acceptable. The use of personal protective equipment is recommended, where applicable, but its use does not negate provisions of this Standard.

#### E1.1 Scope

Hazards to people pertain to the rotating, oscillating, reciprocating, transversing, or other motions associated with equipment used in the mechanical transmission of power (see Figs. 1 through 11).

See ANSI B11, *Standards on Safety Requirements for Construction, Care, and Use of Machine Tools*, for "machine tools" point of operation and related workzone safe practices.

This Standard does not apply to mobile equipment. "Stationary in their use" also includes mechanical power transmission apparatus that is mounted on, part of, or attached to equipment which is capable of being moved when the mechanical power transmission apparatus is not performing its function.

This Standard does not apply to lift trucks, transit concrete mixers, and other similar pieces of mobile equipment.

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<sup>1</sup> This is explanatory material and not a part of the B15.1 Standard.



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**Standard Requirements**

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**1.3 Application — General Requirements**

People having access to areas where motion hazards exist shall be protected, by safeguarding means, from contact with moving parts (mechanisms). Such safeguarding means shall prevent people from walking into, reaching over or under, or other inadvertent contacts.

Where breakage of a machine component can result in injury, provision shall be made for appropriate containment of said components.

When mechanical power transmission apparatus is stopped for servicing purposes, the starting devices, prime movers, or powered accessories shall be locked or tagged out, in accordance with a generalized procedure, to protect all persons or groups exposed to the mechanical power transmission apparatus from an unexpected start.

**1.3.1 Exception — Low Energy.** Certain power transmission apparatus may lack sufficient energy to create a hazard, and therefore safeguarding may not be required.

**1.3.2 Exceptions — Service/Maintenance.** When a safeguard must be bypassed during startup, setup, repair, adjustment, or maintenance, a program to control the unexpected energization of mechanical power transmission apparatus shall be implemented. This program shall be in writing and shall include proper procedures and adequate training of personnel. During testing and positioning of mechanical power transmission apparatus, special procedures shall be implemented and only properly trained and authorized personnel shall be allowed access to a hazard area.

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**Explanatory Notes**

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**E1.3 Application — General Requirements**

It is understood that in the application of this Standard, there are responsibilities incumbent upon the owner, the manufacturer, the installer, the operator, and the user of the power transmission apparatus. Some safeguarding features are incorporated into the design of the equipment. Some protection depends upon the installation of safeguarding features after assembly of all the associated components in the field. Other safeguarding features are a part of a building or structure and are not an integral part of the components themselves. Some protection depends upon the operator and maintenance by the user, and some protection depends upon training and supervision.

When part breakage will result in fragments being propelled, the guard material should be solid, not mesh.

Refer to ANSI Z244.1-1982 (R1993), *Safety Requirements for the Lock Out/Tag Out of Energy Sources* and to OSHA 29 CFR 1910.147, *The Control of Hazardous Energy (Lockout/Tagout)*.

**E1.3.1 Exception — Low Energy.** A study should be made to substantiate the lack of need for safeguarding.

Factors to be considered in making this determination include, but are not limited to, such considerations as speed in radians per second (surface ft per min), diameter of rotating part, smoothness versus roughness of surface, tension of belts, and forces/power involved.

**E1.3.2 Exceptions — Service/Maintenance.** Those personnel involved in these activities should be appropriately trained and should be provided with appropriate tools and safety equipment.

To reduce the chance of injury when safeguards must be bypassed, special procedures and/or equipment for performing this work should be developed and utilized (e.g., lockout, special controls, and/or similar devices, etc.).

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**Standard Requirements**

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**1.4 Effective Date**

The effective date of this Standard for the applicable equipment cited in it shall be 1 year after its date of issuance.

**2 DEFINITIONS**

*belt:* a continuous band or series of links of belting material for transferring motion or power from one wheel, pulley, or shaft to another.

*chain:* a series of links joined together to form a medium for transmitting motion or power from one sprocket or wheel to another.

*gear:* a toothed machine element used to transmit motion without the use of a belt or chain.

*inadvertent contact:* when a person touches or otherwise contacts mechanical power transmission apparatus accidentally.

*mechanical power transmission apparatus:* the mechanical components that, together with a source of power, provide the motion to an element of a machine or equipment.

*mobile:* capable of moving or being moved readily from one place to another.

*motion hazards:* hazards created by movement of components of power transmission apparatus either by themselves or in relation to other components or fixed structures.

*nip point:* a point at which a machine element moving in line meets a rotating element in such a manner that it is possible to nip, pinch, squeeze, or entrap a person or objects coming into contact with one of the two members. This definition holds for the similar point with respect to two rotating parts or two converging parts in linear movement.

*pinch point:* any location at which it is possible for a part of the body to be caught between the moving mechanical power transmission apparatus components and parts of the machine or auxiliary equipment. It is a location where insertion can cause a pinch or squeeze action to the body part.

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**Explanatory Notes**

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**E1.4 Effective Date**

It is not the intent of this Standard to require retrofitting of existing equipment. However, when equipment or the installation is being modified, its performance requirement should be reviewed relative to the current standard. If the performance differs substantially, the need to meet the current requirement should be evaluated.

**E2 DEFINITIONS**

*pinch point:* as used in this Standard, refers only to hazards that may exist as a part of mechanical power transmission apparatus and/or auxiliary components and equipment.

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*point of operation:* point at which cutting, forming, or other functional change is accomplished upon the processed material.

*prime mover:* the primary source of power.

*pulley:* a flat, grooved, or toothed wheel mounted on a shaft, used in the transmission of motion in conjunction with one or more power transmission belts.

*safeguard:* protection provided to people from a hazard by a guard, device, safe distance, or safe location.

*safety markings:* those visual alerts applied to power transmission apparatus through color-coded usage, with or without signs, to denote a hazard.

*shall:* to be understood as mandatory.

*shear point:* other than the point of operation, the immediate area where two or more machine elements pass in close contact, creating a shearing action. The elements may be in any form of motion or one may be at rest.

*should:* to be understood as advisory.

*snag:* to catch on a rough, sharp, or jagged projecting part.

*speed:* a measurement of length of belt, chain, cable, or other linkage which has passed a fixed point within a given time. It is usually expressed in terms of meters per second (ft per min). For rotating elements, speed may be expressed in radians per second (revolutions per min) or in surface meters per second (surface ft per min).

*stationary:* fixed in a station, course, or mode.

**3 SAFEGUARDING OF HAZARDS****3.1 General Requirements**

All motion hazards associated with the operation of mechanical power transmission apparatus shall be eliminated by design of the equipment or protection by a guard, device, safe distance, or safe location.

Employees shall not wear such clothing, jewelry, or unrestrained hair styles as will be hazardous to their personal safety.

**E3 SAFEGUARDING OF HAZARDS****E3.1 General Requirements**

Where possible, sources of motion should be located within the structure of the machine, equipment, or system. When elimination of a hazard by design is not possible, the hazard should be safeguarded.

When there are moving parts such as rotating shafting, cutters, tables, etc., present, particular attention should be given to loose clothing, neckties, finger rings, necklaces, watchbands, and unrestrained hair including beards, goatees, and mustaches, etc.



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**Standard Requirements****Explanatory Notes****3.2 Types of Safeguards**

**3.2.1 Guards.** All motion hazard guards shall meet the following requirements.

(a) They shall prevent entry of hands, fingers, or other parts of the body into a point of hazard by reaching through, over, under, or around the guard.

(b) They shall, in themselves, create no additional motion hazards between the guard and the moving parts.

(c) They shall utilize fasteners not readily removable by people other than authorized persons.

(d) If openings are provided for lubrication, adjustment, or inspection, they shall not cause any additional hazards.

(e) The safeguarding shall prevent injury from breakage of any of the component parts.

**3.2.2 Devices**

(a) A motion hazard safeguarding device shall provide protection to people by:

(1) preventing and/or stopping normal motion of the mechanical power transmission source of hazard if people enter the hazardous area.

(2) providing the means to stop the system in the event of involvement with the hazard.

(b) Emergency stop controls and/or warning signals shall not be used in lieu of guards or other positive safeguarding devices.

**3.2.3 Safe Distance.** Guarding by safe distance shall be accomplished by the following methods:

(a) vertical distance of sufficient height above the floor or other walking or working surface

(b) horizontal distance

(c) the combination of vertical and horizontal distance

**E3.2 Types of Safeguards****E3.2.1 Guards**

(a) Anthropometric studies indicate that conformance with dimensions shown in the chart of Fig. E12, or use of the probe shown in Fig. E13, should achieve the desired degree of safety. (00)

(c) Only fasteners requiring the use of hand tools for removal should be used.

**E3.2.2 Devices**

(1) Presence-sensing mechanisms and interlocked gates, properly interfaced with the sources of power, are examples of this type of device. Appropriate consideration should be given to the stop time of the system once the device has been activated.

(2) Emergency pull cords, body bars, and/or other means to stop the system are examples of this type of device.

**E3.2.3 Safe Distance**

(a) The mechanical power transmission apparatus should be at least 2,440 mm (96 in.) above the surface to be considered as safeguarded by safe vertical distance (or location).

(b) A horizontal distance which precludes contact with the motion hazard meets the intent of this requirement.

(c) The combination of horizontal and vertical distances to provide safe distance protection is shown in Table E1. The vertical barrier will be solid unless barrier openings meet the provisions shown in Fig. E13. (00)



**Standard Requirements****Explanatory Notes**

**3.2.4 Safe Location.** Safeguarding by location can be accomplished by:

- (a) location in a room, vault, or similar enclosure.
- (b) permanent, substantial partitions or screens. Any openings in such partitions or screens shall be so sized and located that persons cannot come into accidental contact with the hazardous moving parts.
- (c) location on an elevated platform where persons cannot come into accidental contact with the hazardous moving parts.

**4 SAFETY LABELS AND SIGNS****4.1 Safety Labels**

Safety labels for application on power transmission equipment shall be in accordance with the ANSI Z535 Standard.

**4.2 Safety Signs.** Signs shall be placed conspicuously in hazardous areas to warn of possible danger or physical injury.

A sign shall not mask or be a hazard itself.

**E3.2.4 Safe Location**

(a), (b), (c) Access to mechanical power transmission apparatus in a vault, room, or closet, or in an area surrounded by a wall, screen, or fence that is controlled by lock and key or other approved means is considered to be restricted access. A wall, screen, or fence less than 2,440 mm (8 ft) in height is not considered adequate to prevent access unless it has other features that provide a degree of isolation equivalent to a 2,440 mm (8 ft) fence [also see paras. 1.3.2, E3.2.1, and E3.2.3(b)].

Access to these locations is restricted to trained personnel who are aware of the hazards. These areas are not workstations.

**E4 SAFETY LABELS AND SIGNS**

For the purpose of selecting the most appropriate signs or labels, the applicable standards are cited as follows:

ANSI Z535.1-1991, Safety Color Code  
ANSI Z535.2-1991, Environmental and Facility Safety Signs  
ANSI Z535.3-1991, Criteria for Safety Symbols  
ANSI Z535.4-1991, Product Safety Signs and Labels  
ANSI Z535.5-1991, Accident Prevention Tags  
Publisher: American National Standards Institute  
(ANSI), 11 West 42nd Street, New York, NY 10036

When used, signs and labels should be so placed to alert and inform the viewer in sufficient time to avoid potential harm from the hazard.

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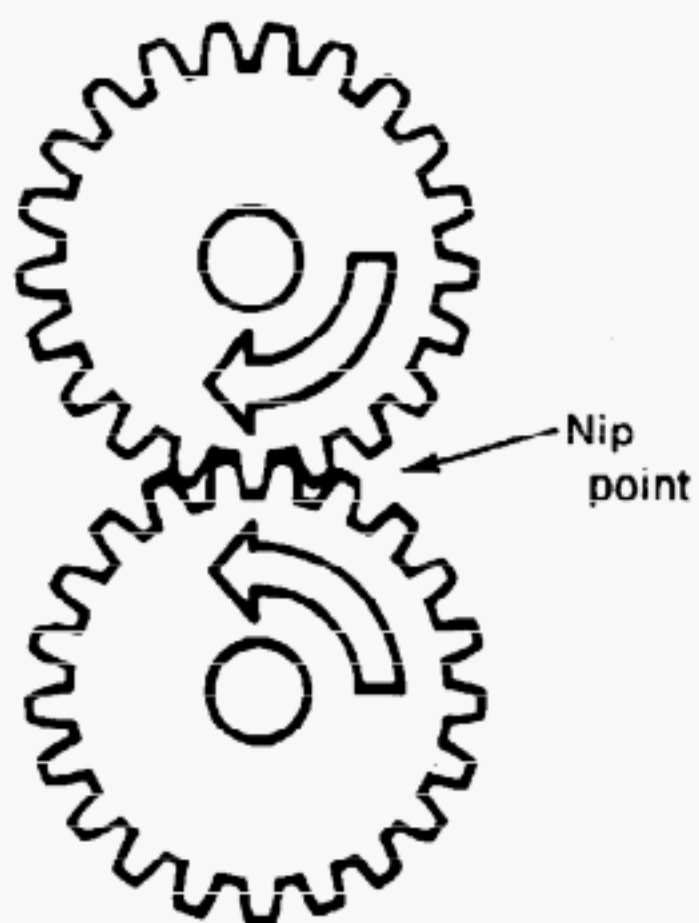


FIG. 1 ROTATING MOTION

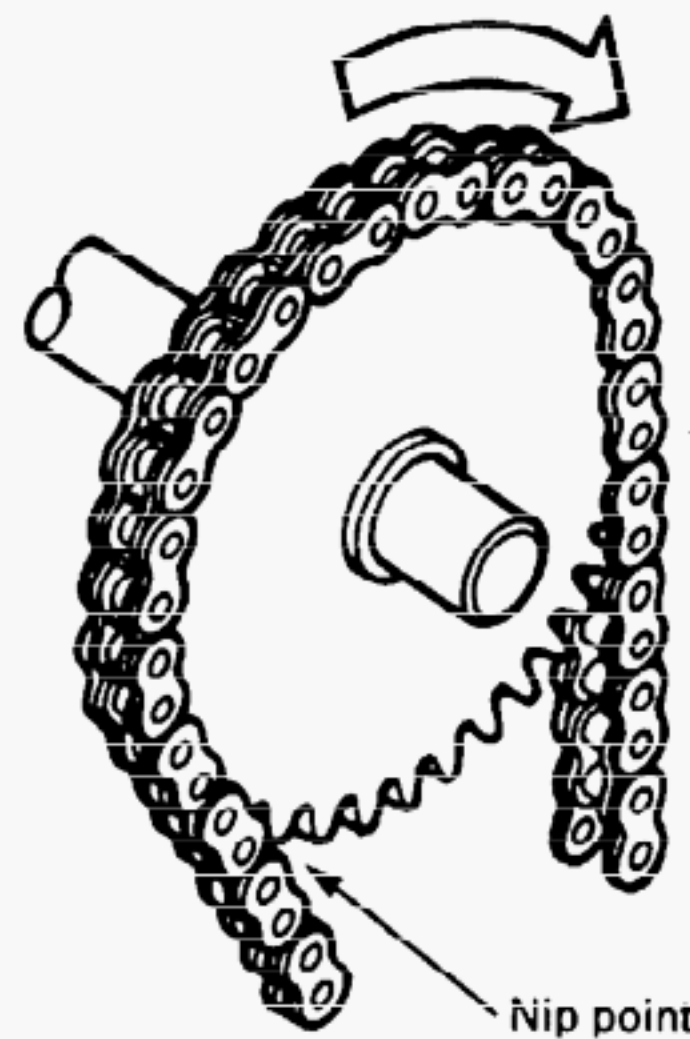


FIG. 2 ROTATING MOTION

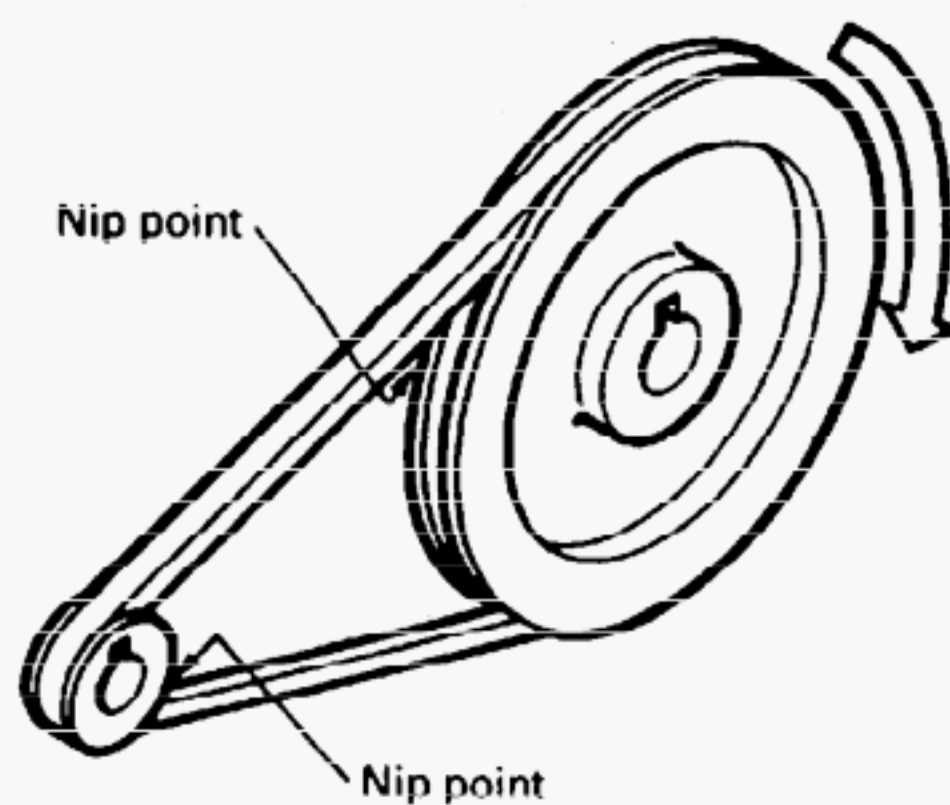


FIG. 3 ROTATING MOTION

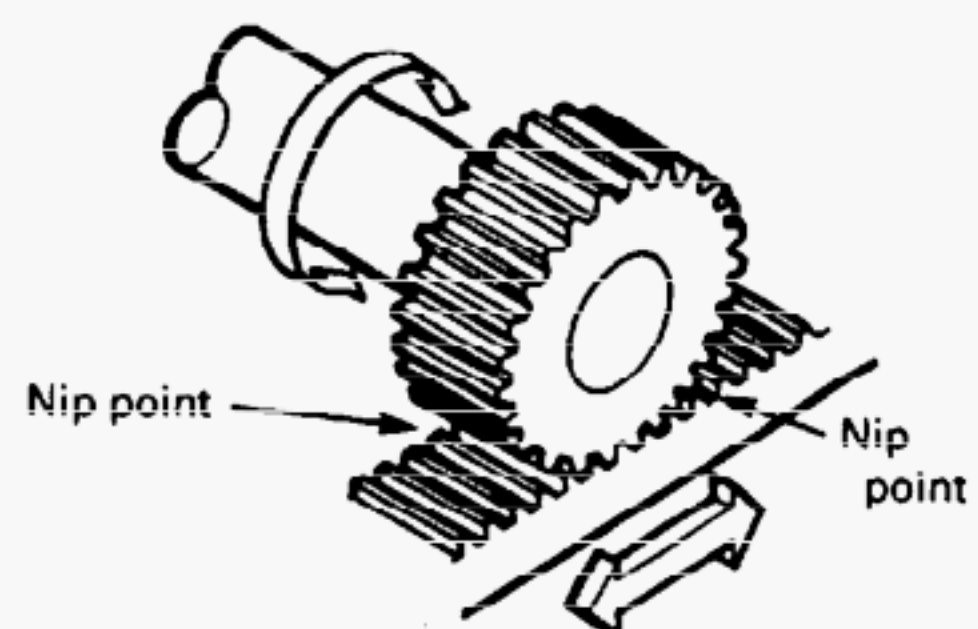


FIG. 4 ROTATING / RECIPROCATING MOTION

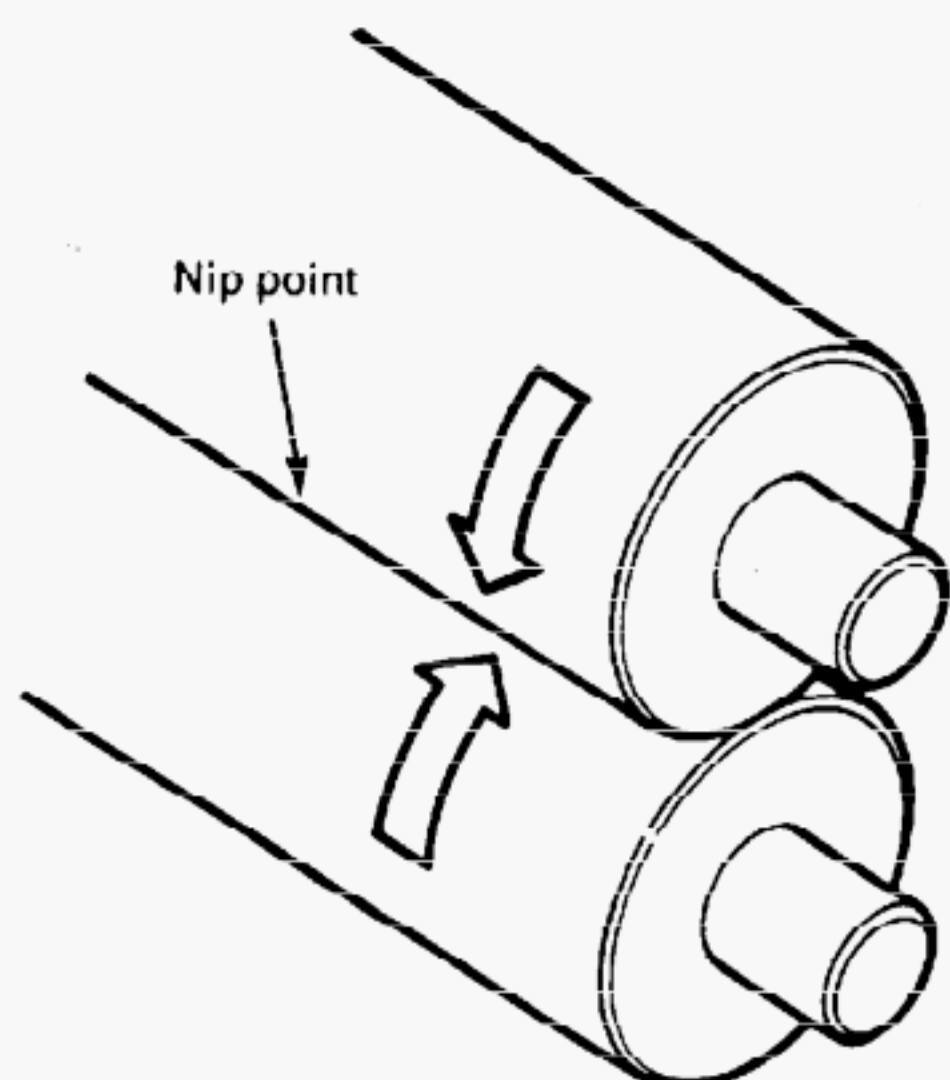


FIG. 5 ROTATING MOTION

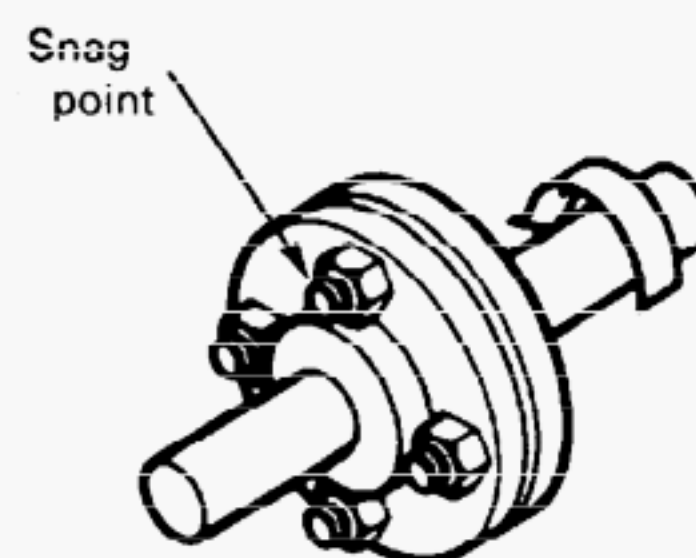


FIG. 6 ROTATING MOTION

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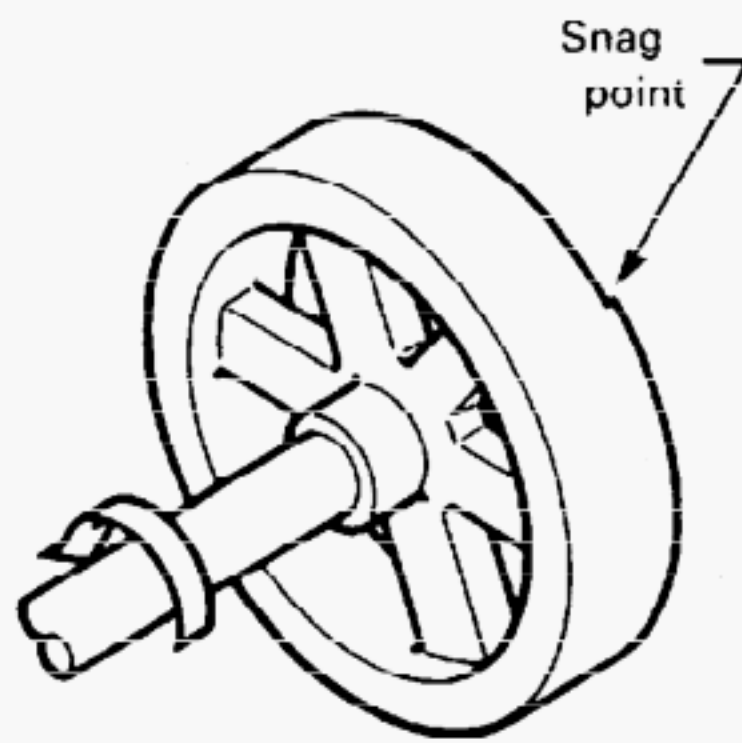


FIG. 7 ROTATING MOTION

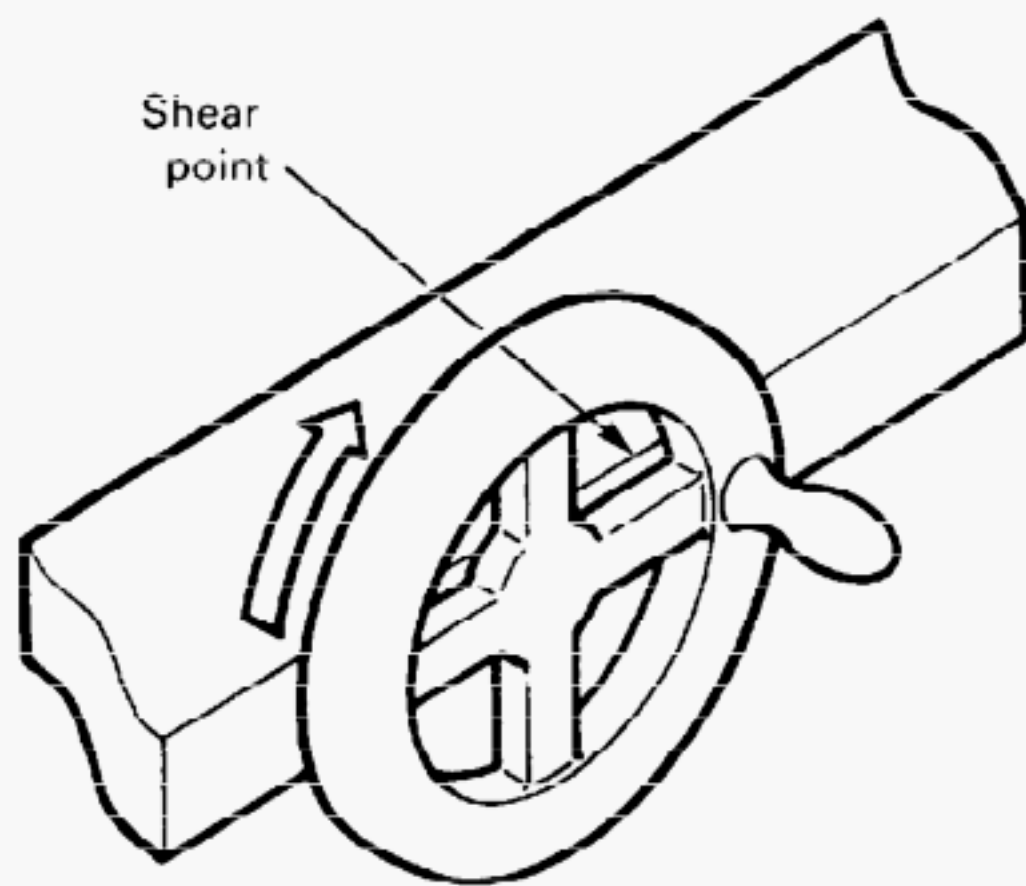


FIG. 9 ROTATING MOTION

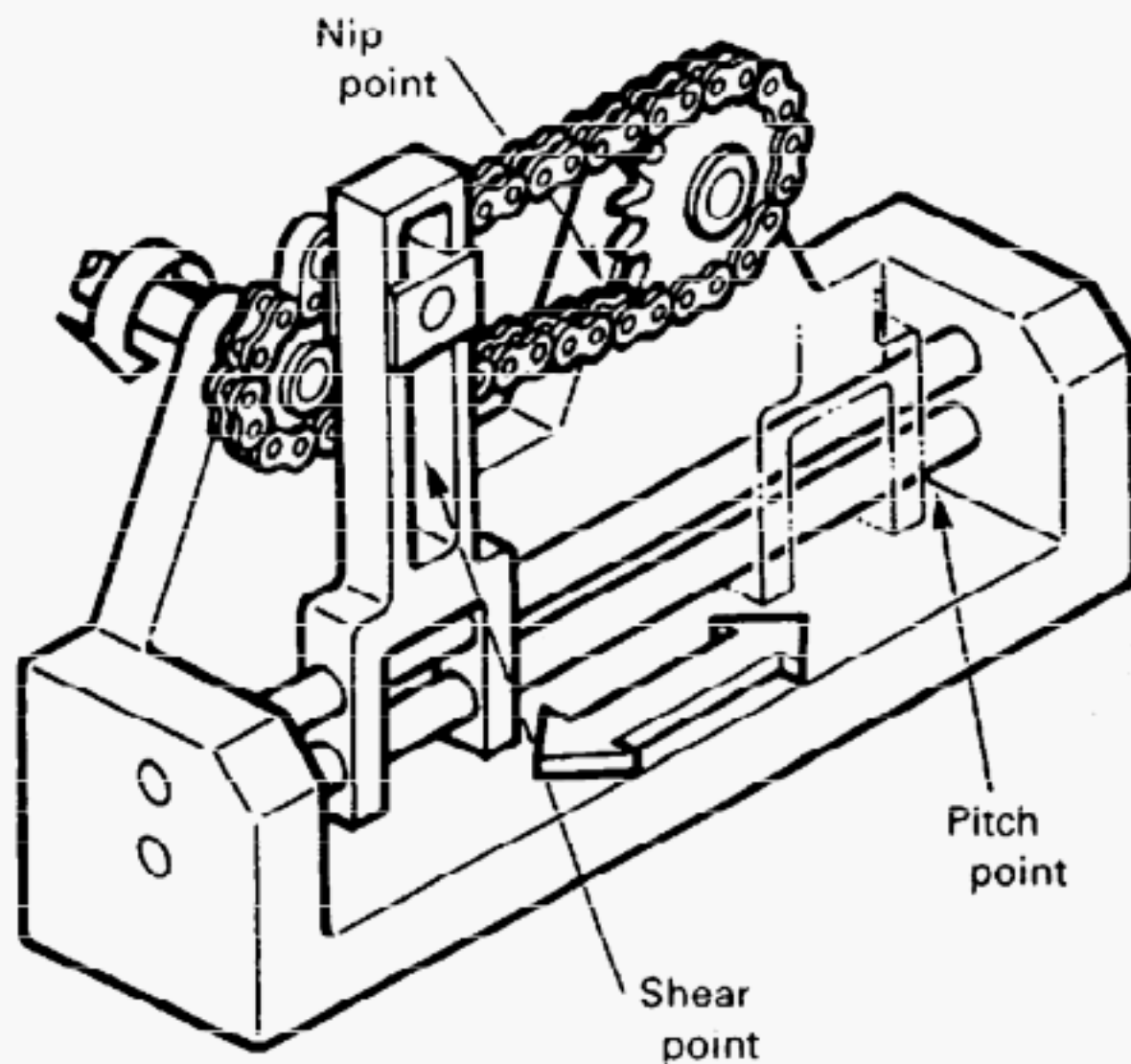


FIG. 11 ROTATING / RECIPROCATING MOTION

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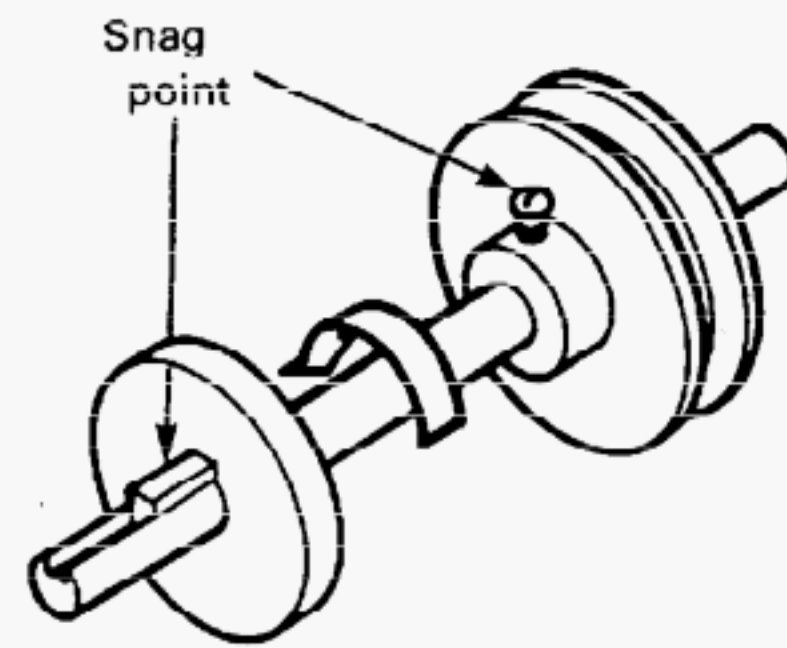


FIG. 8 ROTATING MOTION

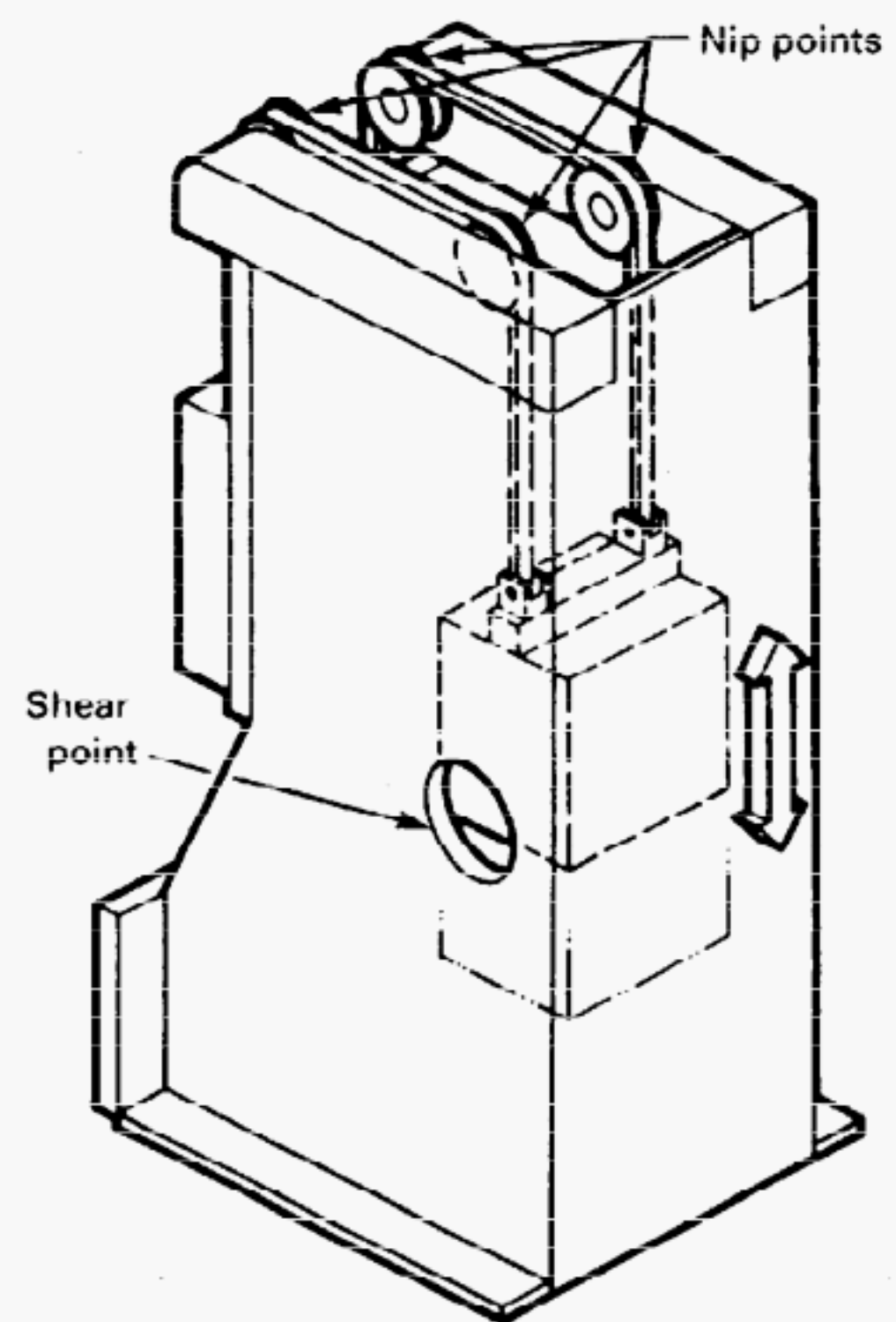
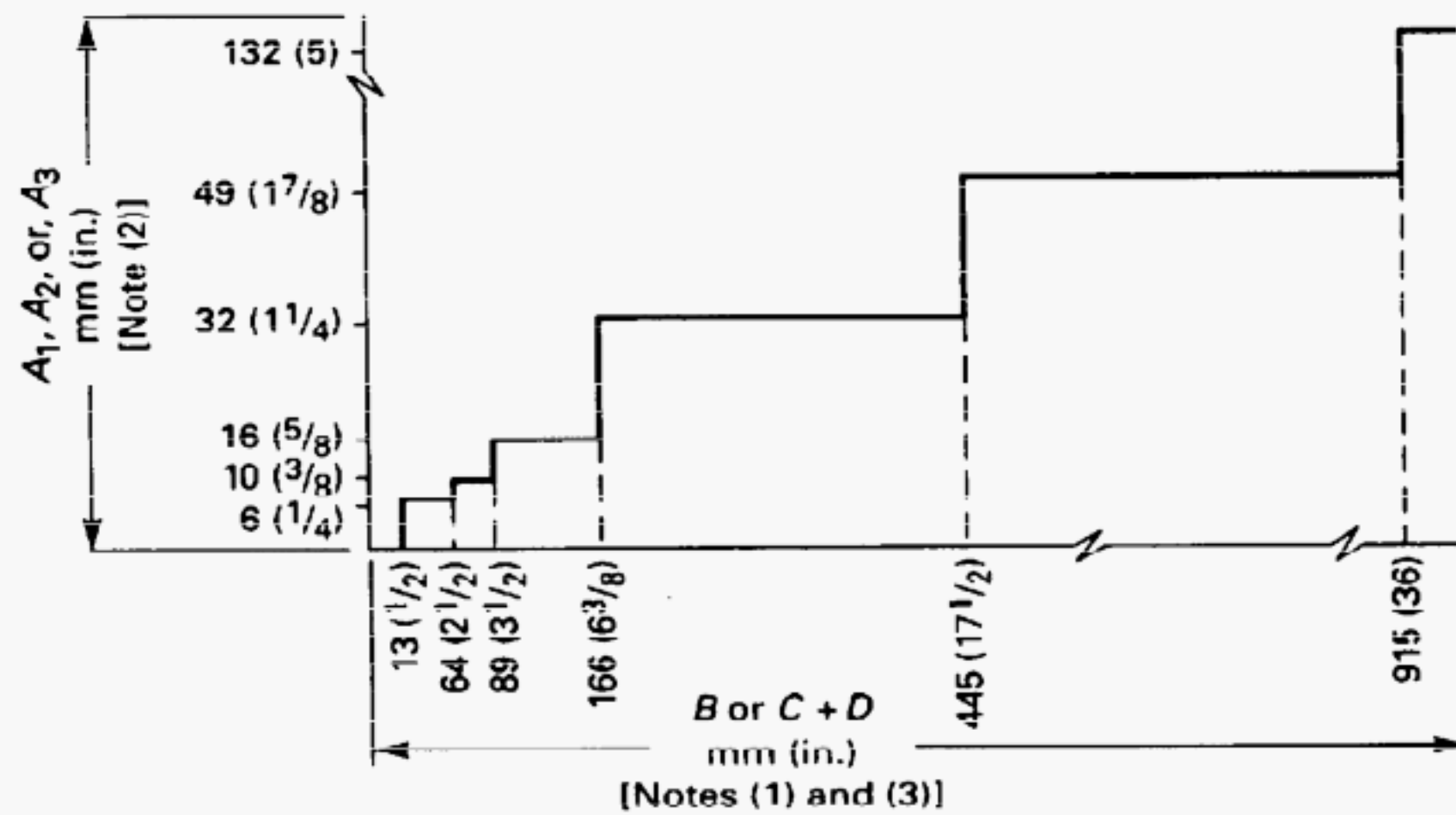


FIG. 10 ROTATING / RECIPROCATING MOTION

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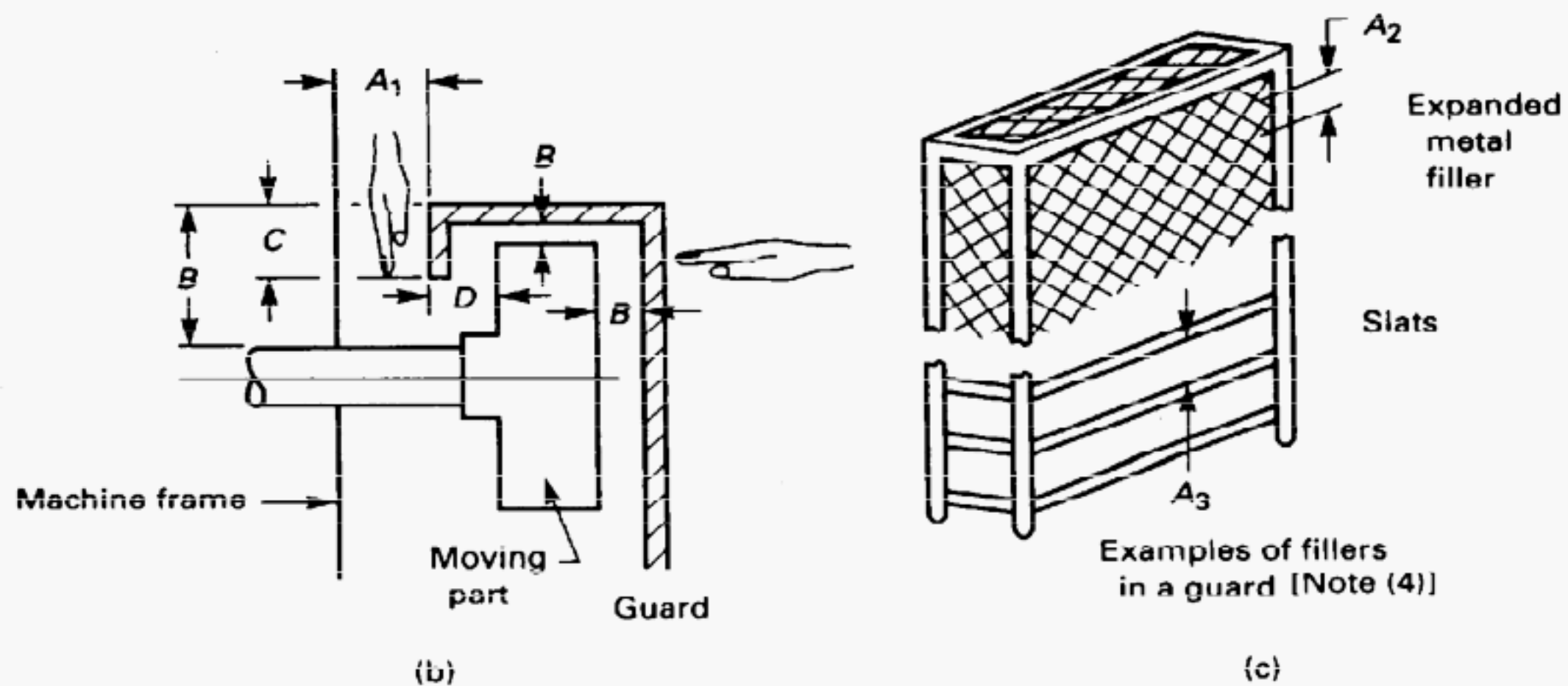
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Width of opening  $A$  may be the opening between the guard and the machine frame as shown by  $A_1$  below.  $A$  may also be the opening in an expanded metal filler ( $A_2$ ) or between slats ( $A_3$ ).  $A$  may also be the opening in a frame or barrier guard.



Distance to moving part to an opening  $A$  must be less than  $B$  or  $C + D$  (whichever is less).

(a)



GENERAL NOTES:

- (a) Values are obtained from the Liberty Mutual Research Center for Safety and Health report, "A Review of Machine Guarding Recommendations," 1996.
- (b) 1 in. = 25.4 mm.

NOTES:

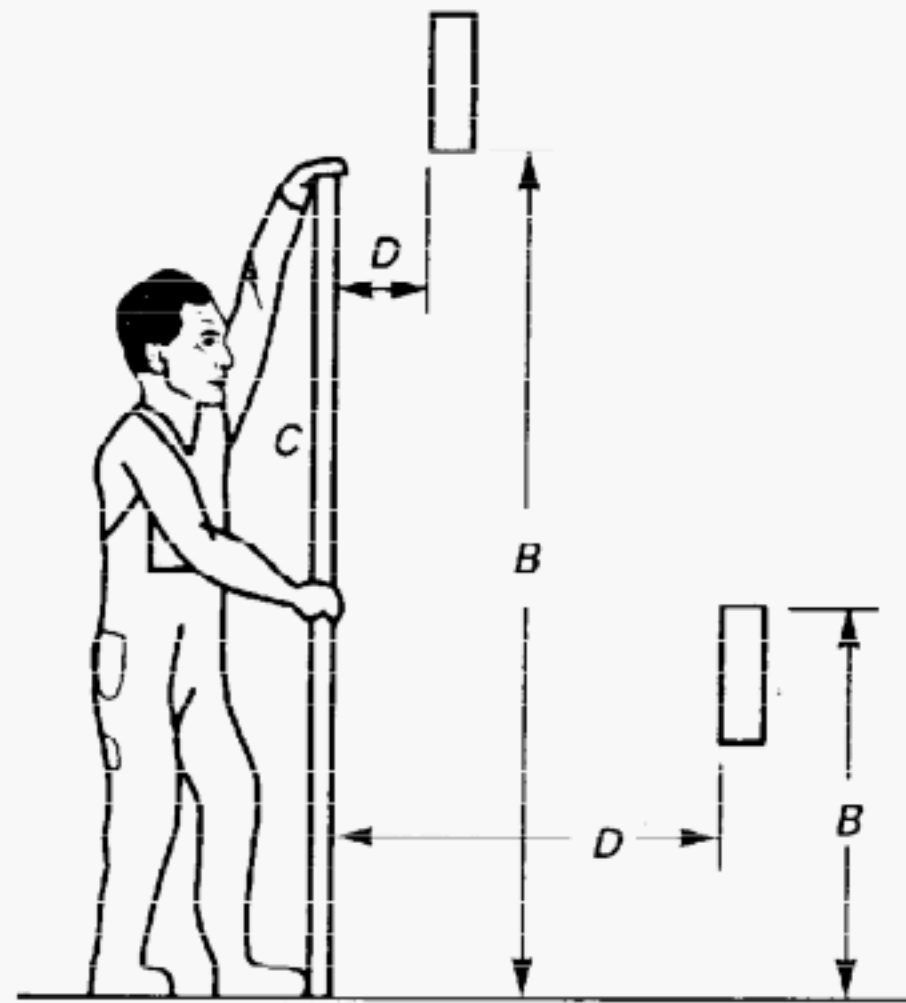
- (1)  $C + D$  applies, in addition to  $B$ , whenever an opening such as  $A$  exists.
- (2) Width of opening  $A$  greater than 132 mm (5 in.) is not permitted.
- (3) A gap opening for  $A$  is not permitted for  $B$  or  $C + D$  distances less than 13 mm ( $1/2$  in.).
- (4) Slats may be vertical, horizontal, or angular.

(00)

FIG. E12 RECOMMENDED SAFEGUARDING DIMENSIONS



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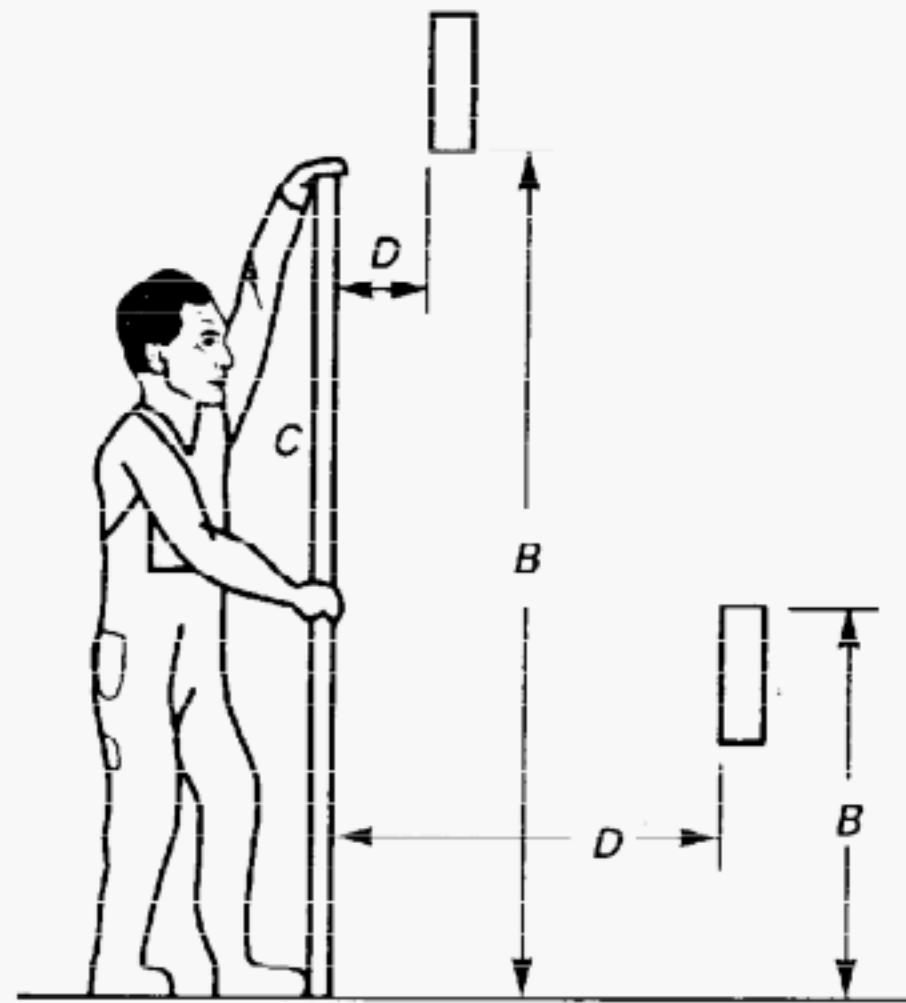
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(00) TABLE E1 HORIZONTAL DISTANCES REQUIRED FROM A BARRIER TO A HAZARD

Vertical Distance From the Ground to the Hazard, <i>B</i> , mm (in.)	Vertical Height of the Barrier, <i>C</i> , mm (in.)							
	2,400 (96)	2,200 (86)	2,000 (78)	1,800 (71)	1,600 (63)	1,400 (55)	1,200 (48)	1,000 (40)
Horizontal Distance From the Barrier to the Hazard, <i>D</i> , mm (in.)								
2,440 (96)	0	100 (4)	100 (4)	100 (4)	100 (4)	100 (4)	100 (4)	100 (4)
2,200 (86)	...	250 (10)	360 (14)	400 (16)	500 (20)	500 (20)	600 (24)	600 (24)
2,000 (78)	...	...	360 (14)	500 (20)	600 (24)	700 (28)	900 (36)	1,100 (43)
1,800 (71)	...	...	...	600 (24)	900 (36)	900 (36)	1,000 (40)	1,100 (43)
1,600 (63)	...	...	...	500 (20)	900 (36)	900 (36)	1,000 (40)	1,300 (51)
1,400 (55)	...	...	...	100 (4)	800 (32)	900 (36)	1,000 (40)	1,300 (51)
1,200 (48)	...	...	...	...	500 (20)	900 (36)	1,000 (40)	1,400 (55)
1,000 (40)	...	...	...	...	300 (12)	900 (36)	1,000 (40)	1,400 (55)
900 (32)	...	...	...	...	...	600 (24)	900 (36)	1,300 (51)
600 (24)	...	...	...	...	...	...	500 (20)	1,200 (48)
400 (16)	...	...	...	...	...	...	300 (12)	1,200 (48)
200 (8)	...	...	...	...	...	...	200 (8)	1,100 (43)

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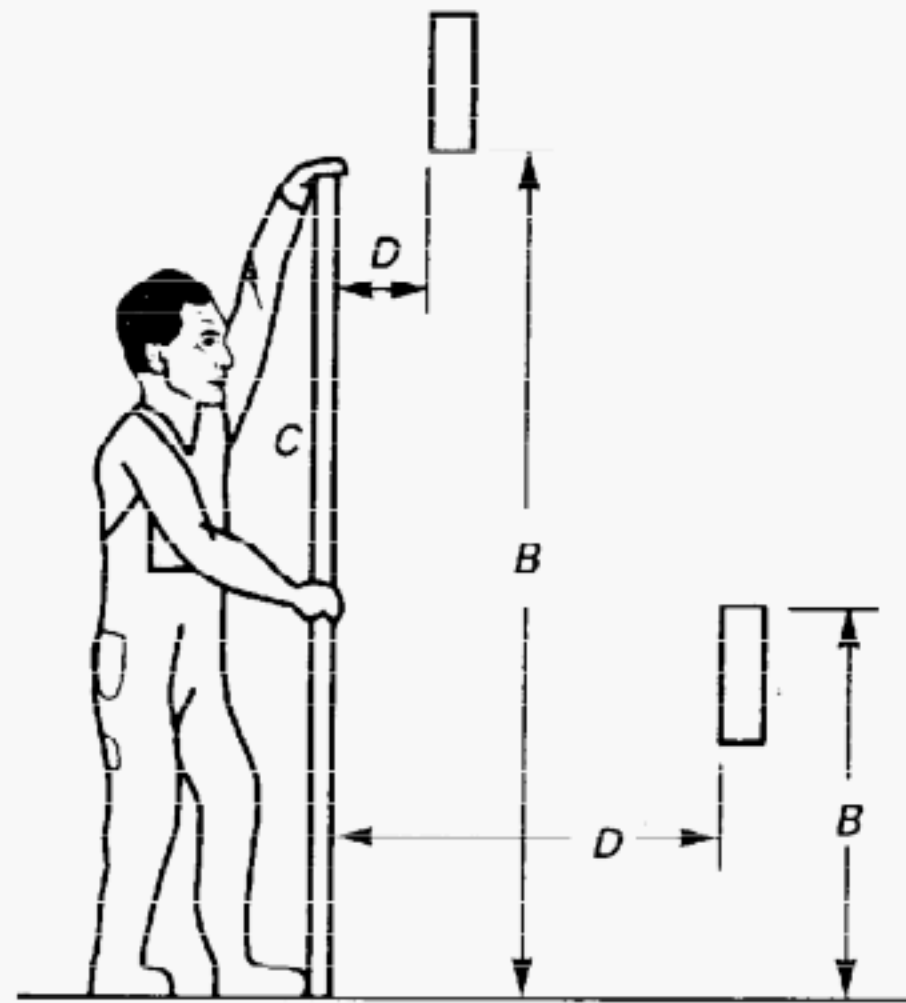
SAFETY STANDARD FOR MECHANICAL POWER  
TRANSMISSION APPARATUS

(00) TABLE E1 HORIZONTAL DISTANCES REQUIRED FROM A BARRIER TO A HAZARD

Vertical Distance From the Ground to the Hazard, <i>B</i> , mm (in.)	Vertical Height of the Barrier, <i>C</i> , mm (in.)							
	2,400 (96)	2,200 (86)	2,000 (78)	1,800 (71)	1,600 (63)	1,400 (55)	1,200 (48)	1,000 (40)
Horizontal Distance From the Barrier to the Hazard, <i>D</i> , mm (in.)								
2,440 (96)	0	100 (4)	100 (4)	100 (4)	100 (4)	100 (4)	100 (4)	100 (4)
2,200 (86)	...	250 (10)	360 (14)	400 (16)	500 (20)	500 (20)	600 (24)	600 (24)
2,000 (78)	...	...	360 (14)	500 (20)	600 (24)	700 (28)	900 (36)	1,100 (43)
1,800 (71)	...	...	...	600 (24)	900 (36)	900 (36)	1,000 (40)	1,100 (43)
1,600 (63)	...	...	...	500 (20)	900 (36)	900 (36)	1,000 (40)	1,300 (51)
1,400 (55)	...	...	...	100 (4)	800 (32)	900 (36)	1,000 (40)	1,300 (51)
1,200 (48)	...	...	...	...	500 (20)	900 (36)	1,000 (40)	1,400 (55)
1,000 (40)	...	...	...	...	300 (12)	900 (36)	1,000 (40)	1,400 (55)
900 (32)	...	...	...	...	...	600 (24)	900 (36)	1,300 (51)
600 (24)	...	...	...	...	...	...	500 (20)	1,200 (48)
400 (16)	...	...	...	...	...	...	300 (12)	1,200 (48)
200 (8)	...	...	...	...	...	...	200 (8)	1,100 (43)

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(00) TABLE E1 HORIZONTAL DISTANCES REQUIRED FROM A BARRIER TO A HAZARD

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	2,400 (96)	2,200 (86)	2,000 (78)	1,800 (71)	1,600 (63)	1,400 (55)	1,200 (48)	1,000 (40)
Horizontal Distance From the Barrier to the Hazard, <i>D</i> , mm (in.)								
2,440 (96)	0	100 (4)	100 (4)	100 (4)	100 (4)	100 (4)	100 (4)	100 (4)
2,200 (86)	...	250 (10)	360 (14)	400 (16)	500 (20)	500 (20)	600 (24)	600 (24)
2,000 (78)	...	...	360 (14)	500 (20)	600 (24)	700 (28)	900 (36)	1,100 (43)
1,800 (71)	...	...	...	600 (24)	900 (36)	900 (36)	1,000 (40)	1,100 (43)
1,600 (63)	...	...	...	500 (20)	900 (36)	900 (36)	1,000 (40)	1,300 (51)
1,400 (55)	...	...	...	100 (4)	800 (32)	900 (36)	1,000 (40)	1,300 (51)
1,200 (48)	...	...	...	...	500 (20)	900 (36)	1,000 (40)	1,400 (55)
1,000 (40)	...	...	...	...	300 (12)	900 (36)	1,000 (40)	1,400 (55)
900 (32)	...	...	...	...	...	600 (24)	900 (36)	1,300 (51)
600 (24)	...	...	...	...	...	...	500 (20)	1,200 (48)
400 (16)	...	...	...	...	...	...	300 (12)	1,200 (48)
200 (8)	...	...	...	...	...	...	200 (8)	1,100 (43)

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