attachments for each of the operator's hands. Such attachments shall be adjusted to prevent the operator from reaching into the hazard area or to withdraw the operator's hands from the hazard area before injury can occur. A separate pullback device shall be provided for each operator, if more than one operator is required on a machine.

4.3.12.3.3 Requirements for holdout or restraint device

A holdout or restraint device, when used, shall include attachments for each of the operator's hands. Such attachments shall be securely anchored and adjusted in such a way that the operator is restrained from reaching into the hazard area. A separate set of restraints shall be provided for each operator, if more than one operator is required on a machine.

4.3.12.3.4 Requirements for a two-hand control device

A two-hand control device shall meet the following requirements:

a) The control actuators shall be protected from unintended actuation and arranged by design, construction or separation so that the concurrent use of both hands of each operator is required to initiate the machine cycle;
b) The control system shall be designed to require the release of all actuators used to initiate the cycle before an interrupted or completed cycle can be resumed or re-initiated;
c) It shall use a control arrangement requiring concurrent operation of the individual operator's hand controls.

E4.3.12.3.4 Requirements for a two-hand control device

a) The word concurrent, as used in this standard, means acting in conjunction with, and is used to describe a situation where two or more control actuators are in an operating condition at the same time.
b) The use of the word concurrent is intended to exclude any implication that a simultaneous moment of actuation must exist between the operation of the individual two-hand operating devices.
c) The word concurrent, as used in this standard, means acting in conjunction with, and is used to describe a situation wherein two or more controls exist in an operating condition at the same time. The use of the word concurrent is intended to exclude any implication that a simultaneous moment of actuation must exist between the operations of

the individual two-hand controls.

4.3.12.4 Requirements for a shield

A shield used to satisfy the requirements of this standard shall:

a) Be an effective barrier for chips and sawdust;
b) Not, in itself, create a hazard(s) such as a pinch point or sharp edge;
c) Be effectively mounted through mechanical, magnetic or other means.

E4.3.12.4 Requirements for a shield

Shields are intended to provide protection for persons who must work in an assigned area(s) and are not intended to contain all chips or wood dust within the machine. A shield may be constructed of any rigid material that does not create a fire hazard.

4.3.12.5 Requirements for an awareness barrier

An awareness barrier used to satisfy the requirements of this standard shall, by contact with the operator, make the operator aware of a hazard or reduce risk of ready entry/access to a hazard area by use of a guardrail or gate/door and enclosure.

E4.3.12.5 Requirements for an awareness barrier

The awareness barrier concept is that of a barrier that moves to provide additional clearance and cannot be lifted or moved without the operator knowing it. Such a barrier also provides visual boundaries to the hazard area. On larger machines and multiple machine installations it may not be possible to safeguard the hazard area and the use of barriers or gate/ enclosures may be the only practical method of safeguarding. An example of this is when industrial robots are used for material handling.

4.3.12.6 Requirements for an awareness device

An awareness device used to satisfy the requirements of this standard shall be such that it will:

a) Issue a warning sound to alert an operator or other personnel of an approaching hazard or alert personnel during the period when a hazard exists. This sound shall be distinctive to distinguish it from other existing sounds;
b) Give out a visible warning light to alert an operator or other personnel of an approaching hazard or alert

E4.3.12.6 Requirements for an awareness device

Such devices may be desirable where a hazard could exist part of the time; for instance, during startup of transfer machines.

personnel during the period when a hazard exists.

4.3.13 Machine stability hazards

4.3.13.1 Machines designed for a fixed location

Machines designed for a fixed location shall be securely anchored to prevent walking, tilting, or moving. All other machines must meet the requirements of 4.3.13.3, below.

4.3.13.1.1 All machines shall be provided with bolt holes or other means for securing to the floor or supporting structure.

4.3.13.2 Casters or wheels

Casters or wheels that support a machine shall be retractable or of a locking design.

4.3.13.3 Stability tests

Machines not anchored or secured to the floor, wall or ceiling shall meet the following stability tests.

4.3.13.3.1 When lifted from any side such that the machine is tilted 7 degrees from its at rest position, the machine will return to its at rest position when the lifting force is removed.

4.3.13.3.2 A machine installed in accordance with the manufacturer's instructions shall not overturn when any doors, empty drawers, movable tables, or other appurtenances are placed in any position to which they are capable of being moved without the use of a hand tool. The machine need not be capable of normal operation when components are positioned for this test.

E4.3.13.3.2 Manufacturers should also consider the possibility of loaded drawers being opened.

4.3.14 Pinch, nip, and crush hazards

E4.3.14 Pinch, nip, and crush hazards

Where practical, pinch, nip and/or crush

Pinch points exist where two or more

hazards shall be eliminated or safeguarded if they are accessible during normal operation and/or maintenance.

objects, any of which is in motion, meet or come near one another. This can occur as a result of rotation or linear motion. Nip is another term for Pinch.

Crushing is similar to pinching, except at a greater magnitude. Crushing generally involves damage to bone or other structure whereas pinch may not.

Other terms of art are nip point, pinch point, etc.

4.3.14.1 Positive barriers

Barriers and machine structure which physically restrict or prevent access to the hazard zone are considered guards for the purposes of this requirement.

4.3.14.2 Awareness barriers

E4.3.14.2 Awareness barriers

Awareness barriers are acceptable only where other means of safeguarding listed above are not practical.

Awareness barriers do not necessarily prevent or restrict access. Rather, they serve to make the operator aware of the hazard zone without restricting access to the zone.

4.3.14.3 Warning labels

Warning labels are acceptable as a substitute for awareness barriers only when no other practical alternative is available.

4.3.15 Hazards from workpiece ejection

E4.3.15 Hazards from workpiece ejection

The manufacturer, where practical, shall provide means to reduce the risk of workpieces being forcefully ejected from machines. These means shall address the possibility of wrong way feed and may include other means.

Positive means for preventing wrong way feed should be used where practical. Some machines such as manual fed spindle shapers do not lend themselves to such devices, in which case warnings and instructions should be used.

4.3.15.1 Kickback

E4.3.15.1 Kickback

Resistance of a rotating abrasive or cutting tool contacting the workpiece applies force tangential to the direction of rotation of the tool. When this force is in the direction opposite the feed direction of the workpiece and it is unchecked or uncontrolled, a potential of kickback exists. The potential for kickback occurs when a cutting tool binds in the workpiece and can be caused by a variety or combination of factors, including, but not limited to, poorly maintained cutters or blades, improperly aligned guide fences, irregularities in workpieces, excessive feed rates, wrong way feed, and/or operator inattention.

The hazard created may be either the thrown workpiece or the exposed work processing means such as a saw, cutter, or abrasive head or belt.

4.3.15.2 Overfeed

E4.3.15.2 Overfeed

Resistance of a rotating abrasive or cutting tool contacting the workpiece applies force tangential to the direction of rotation of the tool. When this force is in the same direction as the feed direction of the workpiece and it is unchecked or uncontrolled, a potential of overfeed exists. The potential for overfeed occurs when a cutting tool binds in the workpiece and can be caused by a variety or combination of factors, including, but not limited to, poorly maintained cutters or blades, improperly aligned guide fences, irregularities in workpieces, excessive feed rates, wrong way feed, and/or operator inattention.

The hazard created may be either the thrown workpiece or the exposed work processing means such as a saw, cutter, or

abrasive head or belt.

4.3.15.3 Thrown workpiece

E4.3.15.3 Thrown workpiece

A rotating tool such as found on a router or drill press can throw the workpiece in any direction, radially. Thrown workpiece is associated with moving rotating abrasive or cutting tools contacting fixed workpieces in such a way as to lift and/or throw the workpiece. The potential for thrown workpiece occurs when a cutting tool binds in the workpiece and can be caused by a variety or combination of factors, including, but not limited to, poorly maintained cutters or blades, improper workpiece supports, irregularities in workpieces, excessive feed rates, and/or operator inattention.

The hazard created may be either the thrown workpiece or the exposed work processing means such as a saw, cutter, or abrasive head or belt.

4.3.16 Projectiles

E4.3.16 Projectiles

The manufacturer, where practical, shall provide means to reduce the risk of projectiles being forcefully ejected from machines.

Projectiles generally involve the ejection of parts, either machinery and or processed materials/workpieces. Rapidly moving or rotating parts, and everything in their vicinity, are capable of becoming projectiles. For example, clamps or guards in the vicinity of a rotating cutter can become projectiles if they contact the cutter.

4.3.16.1 Where ejected materials cannot be contained, personnel in the vicinity of the machine shall be protected by suitable means, such as guarding or face and eye protection.

4.3.16.2 Where practical, components having motion sufficient to throw projectiles capable of injury shall be safeguarded to reduce the

risk of such projectiles inflicting injury.

4.3.16.3 Personal protective devices, such as face or eye protection should be used where ejected materials cannot be contained.

4.3.17 Impact hazards

E4.3.17 Impact hazards

Where practical, safeguarding means shall be used to isolate machine, workpiece, or other movements from employees where such movement can result in impact injuries.

Examples of machines or conditions which can result in impact are Robotic arms, CNC machine centers, projectiles, Kick Back, material movement or conveyance.

4.3.18 Entanglement and entrapment hazards

E4.3.18 Entanglement and entrapment hazards

Loose clothing, jewelry, long hair, gloves, fingers, hands, etc. can become entangled in rotating or moving parts.

Entanglement/entrapment hazards may exist while operating, but may also exist when loading, unloading, adjusting, measuring, cleaning, or similar operations.

4.3.18.1 Entanglement

Where practical, entanglement hazards shall be safeguarded.

4.3.18.2 Entrapment

E4.3.18.2 Entrapment

On machines operating in the automatic or semiautomatic mode, a guard, guarding device, or awareness barrier is required when it is necessary for any part of the operator's body to be in close proximity of the trapping space for the purpose of loading, unloading, adjusting, measuring, cleaning up or similar operations. Awareness barriers are only acceptable where there is no other appropriate alternative.

"Close proximity" has usually been accepted to be approximately 12 inches of the hazard.

4.3.19 Abrasion hazards

Where practical, moving machine surfaces shall be designed or safeguarded to reduce the risk of abrasion injury.

4.3.20 Miscellaneous hazards

4.3.20.1 Provisions, attachments, systems and/or accessories provided for the purpose of lifting materials

E4.3.20.1 Provisions, attachments, systems and/or accessories provided for the purpose of lifting materials

Provisions, attachments, systems and/or accessories provided for the purpose of lifting materials shall comply with the appropriate currently published and nationally recognized standards.

There are numerous ANSI/ASME standards for hoists, for example.

4.3.21 Radiation hazards

4.3.21.1 Ionizing radiation

E4.3.21.1 Ionizing radiation

All woodworking and accessory equipment using ionizing radiation shall comply with the applicable provisions of Title10 CFR Part 20 "Standards for Protection Against Ionizing Radiation."

Ionizing radiation injury can be caused by x-rays, gamma rays, alpha particles, beta particles, neutrons, and other nuclear particles.

4.3.21.2 Non-ionizing radiation

E4.3.21.2 Non-ionizing radiation

All woodworking and accessory equipment shall comply with the applicable provisions of the current edition of the American Conference of Governmental Industrial Hygienists "Threshold Limit Values for Chemical Substances and Physical Agents."

Non-ionizing radiations include ultraviolet lamps, electric arc welding, plasma torches, high-intensity lights in photocopying machines, sources of "black light", lasers, heating elements, high temperature furnaces, molten metal, fires and explosions, and microwave ovens.

4.4 Controls

4.4.1 Operator controls

4.4.1.1 Access controls

Access Controls shall be located such that they are within the normal reach of a machine operator from the operating position(s) and not require that the

operator(s) reach over, under or past unguarded moving parts, workpieces or cutters that can cause injury.

4.4.1.2 Unintended actuation

E4.4.1.2 Unintended actuation

Controls shall be designed to minimize the possibility of unintended actuation by the normal movement of the machine operator or work. EXCEPTION: This requirement does not apply to emergency stop controls.

Ease of access and multiple operating capability means are of primary importance on emergency stop controls. (See ANSI/NFPA 79.)

4.4.1.3 Identification

E4.4.1.3 Identification

The function of controls shall be clearly identified when their function is not self-evident.

See ANSI/NFPA 79.

4.4.1.4 Jog control(s)

The jog control(s) shall be hold-to-run.

4.4.1.5 Mechanical controls

4.4.1.5.1 Hand wheels, direction of rotation

E4.4.1.5.1 Hand wheels, direction of rotation

A handwheel turned in a clockwise rotation should produce, for the controlled component, a linear movement to the right, away or upward. If rotary motion is produced by the handwheel, clockwise rotation should cause clockwise movement of the controlled component. Counterclockwise rotation of the handwheel should produce motion opposite that of clockwise rotation.

This is the preferred action. However, there are exceptions where this is not possible, such as a handwheel at both ends of the same shaft.

4.4.1.5.2 Levers, direction of motion

E4.4.1.5.2 Levers, direction of motion

A control lever should move in the same direction as the controlled component when both motions are parallel.

This is the preferred action. However, there are exceptions where this is not possible.

4.4.1.6 Multiple control stations

4.4.1.6.1 Setup control station

When a separate setup control station(s) is provided in addition to the normal operator's control station, selection of the setup station(s) shall render the operator's station inoperative, except for emergency stop. Switching from one control station to another shall not create a hazard.

E4.4.1.6.1 Setup control station

A setup control station(s) is normally not capable of cycling the machine. It is basically a jog/ inch control station used to set up a part of a multi-station machine. Keyed on-off controls are generally used to lock out all other stations when a particular station is being used.

4.4.1.6.2 Multiple operators

When more than one operator is required to operate the machine from different control stations, each station shall be provided with a cycle start button and all cycle start buttons must be depressed concurrently in order to initiate the cycle.

4.4.1.6.3 Multiple operating stations, one operator

When one operator can operate the machine from more than one station, all cycle start buttons other than the one being used shall be made inoperative.

4.4.1.6.4 Multiple part loading

Where parts are manually loaded and where the operator is exposed to a hazard due to cutter or machine component movement, the transfer of a part(s) from one position to another shall only occur when initiated by the operator.

4.4.2 Emergency stop control

4.4.2.1 Application

All machines shall incorporate one or more emergency stopping means, which upon momentary operation, shall safely stop all machine motions. These emergency stopping means shall be located at all operator control stations and, if inherent hazards are present at other operating positions, an emergency

E4.4.2.1 Application

Emergency stopping means include pull cables, mushroom buttons, pressure mats, presence sensing devices and similar devices. Set up positions are not considered operator control positions.

stopping means shall be provided at each position. EXCEPTION: On a manual machine with a single motor and motor controller, the motor stopping means is considered the emergency stop.

4.4.2.2 Color

The emergency stop(s) actuator shall be red in color. (See ANSI Z535.1.)

4.4.2.3 Accessibility

Emergency stop actuating means shall be readily accessible and not in a location that requires anyone activating it to reach over, under or around a hazard.

E4.4.2.3 Accessibility

Stopping means should be within normal reach of the operator and the operator should not be exposed to an unguarded hazard to activate it.

4.4.2.4 Function

The emergency stopping means shall override all other controls and, when actuated, shall not create a hazard.

4.4.2.5 Restart

All machine motions stopped by an emergency stop control(s) shall be restartable only by an intentional operator action.

4.4.3 Power-operated clamping

When power operated clamping is used, it shall be so designed so as not to release due to a failure or actuation of the emergency stopping means. Release shall be accomplished by either the completion of the cycle or an intentional action by the operator.

E4.4.3 Power-operated clamping

This may be accomplished by the use of toggles, wedges, cam lock arrangements, accumulator tanks with check values, or by other means.

4.4.4 Control function

A control device shall not be used to initiate any motion unrelated to its designation.

E4.4.4 Control function

When an unanticipated motion occurs it can cause an operator reaction which results in an injury.