



Designation: E2349 – 19

# Standard Practice for Safety Requirements in Metal Casting Operations: Sand Preparation, Molding, and Core Making; Melting and Pouring; and Cleaning and Finishing<sup>1</sup>

This standard is issued under the fixed designation E2349; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## INTRODUCTION

This practice is part of a project started in 1972 under the sponsorship of the American Foundry Society, Inc. Standard for Safety Requirements in Metal Casting Operations—Sand Preparation, Molding, and Core Making; Melting and Pouring; and Cleaning and Finishing.

The metal casting industry shares safety considerations with many other industries requiring the movement of heavy objects, the use of large ovens and melt furnaces, and processing of hot materials. In addition, there are safety considerations common to all industries. The present trend is towards the development of industry-wide standards wherever the need for safety considerations exists. This practice, therefore, is limited to safety considerations of special importance in the metal casting industry operations in which general standards do not exist or are not considered adequate. This practice is not intended to supersede or replace any applicable federal, state, or local governmental safety regulations or requirements, but rather, it is intended to augment and support any such requirements. Operating rules are not included in this practice unless they are vital to safety.

Compliance with this practice should provide a relatively safe environment, which is a fundamental requirement in preventing occupational injuries.

## Contents

### Introduction

- 1 Scope
- 2 Referenced Documents
- 3 Terminology
- 4 Materials and Manufacture
- 4.1 Responsibility
- 4.2 Inherent Hazards
- 4.3 Installation
- 4.4 Power Requirements
- 4.5 Electrical Ground Faults
- 4.6 Fluid Power Off
- 4.7 Electrical Equipment Grounding
- 4.8 Fluid Exhaust (Gas or Liquid)
- 5 Care of Equipment – General Provisions
- 5.1 Instructions
- 5.2 Installation
- 5.3 Inspection and Preventive Maintenance
- 5.4 Maintenance Personnel Training and Experience
- 5.5 Startup Procedure
- 5.6 Shutdown Procedure
- 5.7 Troubleshooting, Maintenance, and Repair
- 6 Safeguards – General Requirements
- 6.1 Responsibility for Safeguarding
- 6.2 Guarding
- 6.3 Hazard Zone Guarding
- 6.4 Hazard Zone Protective Devices
- 7 Operation of Equipment – General Requirements
- 7.1 Employer's Responsibility
- 7.2 Employee's Responsibility
- 8 Sand Preparation, Molding, and Core Making
- 8.1 Sand Handling and Preparation

- 8.2 Core Making
- 8.3 Molding Equipment
- 8.4 Fuel-Fired Equipment
- 8.5 Operation Procedures for Sand Preparation, Molding, and Core Making
- 9 Melting and Pouring
- 9.1 Cupola
- 9.2 Electric Furnaces – Induction Melting and Induction Holding
- 9.3 Electric Furnaces – Direct Arc Furnaces
- 9.4 Ladles
- 9.5 Molten Metal Handling and Pouring Equipment
- 9.6 Maintenance and Inspection
- 9.7 Molten Metal Treatment
- 9.8 Specific Material Handling Equipment
- 9.9 Molten Metal Handling and Pouring
- 9.10 Overhead Handling of Molten Material
- 10 Cleaning and Finishing
- 10.1 Care of Cleaning and Finishing Equipment
- 10.2 Specific Equipment Safeguards – Cleaning and Finishing
- 10.3 Abrasive Blasting
- 10.4 Chipping
- 10.5 Abrasive Wheels
- 10.6 Operating Procedures for Abrasive Wheels
- 10.7 Portable Abrasive Wheels
- 10.8 Grinding Magnesium
- 10.9 Molten Salts Cleaning
- 10.10 Hooks Designed for Handling Castings
- 10.11 Slings
- 10.12 Lighting
- 11 Keywords

## 1. Scope

1.1 This practice covers the requirements of applying the design, construction, and operation of the machinery and equipment used in metal casting operations—sand preparation, molding and core making, melting and pouring, and cleaning and finishing. This practice does not apply to die casting operations.

1.2 *Purpose*—The requirements of this practice, including the training of supervisors and employees, are intended to minimize the possibility of injury to operating and maintenance personnel while working on, or in the vicinity of, the specified equipment. Compliance with this practice, in conjunction with OSHA regulations, provides a relatively safe environment, which is a fundamental requisite in helping to prevent occupational injuries.

### 1.3 *Application:*

1.3.1 *New Installations*—After the date of publication, all new installations within the scope of this specification shall be in conformance with its requirements. Any existing machine installation moved to a new plant or another location in the same plant is deemed a new installation when it is installed in the new location. However, an existing installed machine (former installation) that is moved for a short distance, for example, to provide additional aisle space, is not deemed to be a new installation.

1.3.2 *Existing Installations*—After the approval date of this practice, installations existing on, or before, this date shall be modified as necessary to be in conformance with all requirements of this practice. Where it is not practical to modify an existing facility in conformance with this practice, deficiencies shall be noted and plans for compliance shall be included in any future facility or equipment changes. Those facilities and equipment on order or in the process of construction on the date of publication of this practice shall be considered as an existing installation. This practice applies to existing equipment if it lacks the necessary employee protection (personal protective equipment or administrative controls).

1.4 The values stated in inch/pound units are to be regarded as the standard. The values in brackets are for information only.

1.5 The text of this practice references notes and footnotes which provide explanatory material. These notes and footnotes (excluding those in tables and figures) shall not be considered as requirements of the standard.

1.6 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.7 *This international standard was developed in accordance with internationally recognized principles on standard-*

*ization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

## 2. Referenced Documents

### 2.1 *ASTM Standards:*<sup>2</sup>

[E1542 Terminology Relating to Occupational Health and Safety](#)

[F1002 Performance Specification for Protective Clothing and Materials for Use by Workers Exposed to Specific Molten Substances and Related Thermal Hazards](#)

[F1449 Guide for Industrial Laundering of Flame, Thermal, and Arc Resistant Clothing](#)

[G88 Guide for Designing Systems for Oxygen Service](#)

[G128/G128M Guide for Control of Hazards and Risks in Oxygen Enriched Systems](#)

### 2.2 *ANSI Standards:*<sup>3</sup>

[ANSI/ASSP A1264.1 Safety Requirements for Workplace Walking/Working Surfaces and Their Access; Workplace, Floor, Wall, and Roof Openings; Stairs and Guardrail/Handrail Systems](#)

[ANSI B7.1 Safety Requirements for the Use, Care and Protection of Abrasive Wheels.](#)

[ANSI B11.6 Safety Requirements for Manual Turning Machines with or without Automatic Control](#)

[ANSI B11.9 Safety Requirements for Grinding Machines](#)

[ANSI B11.TR3 Risk Assessment and Risk Reduction—A Guide to Estimate, Evaluate and Reduce Risks Associated with Machine Tools](#)

[ANSI B15.1 Mechanical Power Transmission Apparatus](#)

[ANSI/ASSP Z9.2 Fundamentals Governing the Design and Operation of Local Exhaust Ventilation Systems](#)

[ANSI/ASSP Z9.4 Ventilation and Safe Practices of Abrasive Blasting Operations](#)

[ANSI/ASSP Z244.1 Control of Hazardous Energy Lockout, Tagout, and Alternative Methods](#)

[ANSI/ASSP Z359 Fall Protection](#)

[ANSI/ASSP Z490.1 Criteria for Accepted Practices in Safety, Health and Environmental Training](#)

[ANSI Z535.1 Safety Color Code](#)

[ANSI Z535.2 Environmental and Facility Safety Signs](#)

[ANSI Z535.3 Criteria for Safety Symbols](#)

[ANSI Z535.4 Product Safety Signs and Labels](#)

[ANSI Z535.5 Accident Prevention Tags](#)

### 2.3 *ASME Standards:*<sup>4</sup>

[ASME B5.35 Machine Mounting for Abrasive Discs and Plate-Mounted Wheels](#)

[ASME B107.4 Driving & Spindle Ends for Portable Hand, Air and Electric Tools \(Percussion Tools Excluded\)](#)

<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

<sup>3</sup> Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>.

<sup>4</sup> Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Two Park Ave., New York, NY 10016-5990, <http://www.asme.org>.

<sup>1</sup> This practice is under the jurisdiction of ASTM Committee E34 on Occupational Health and Safety and is the direct responsibility of Subcommittee E34.10 on Industrial Safety.

Current edition approved March 1, 2019. Published March 2019. Originally approved in 2005. Last previous edition approved in 2018 as E2349 – 18. DOI: 10.1520/E2349-19.

ASME B20.1 Safety Standard for Conveyors and Related Equipment (ASME B20.1)

ASME B30.2 Overhead and Gantry Cranes (Top Running, Bridge, Single or Multiple Girder Top Running Trolley Hoist)

ASME B30.5 Safety Code for Crawler, Locomotive, and Truck Cranes

ASME B30.9 Slings

ASME B30.10 Hooks

ASME B30.11 Monorails and Underhung Cranes

ASME B30.20 Below-the-Hook Lifting Devices

2.4 CGA Standard:<sup>5</sup>

CGA G-4.4 Industrial Practices for Gaseous Oxygen Transmission and Distribution Piping Systems

2.5 IAPMO Document:<sup>6</sup>

Uniform Plumbing Code

2.6 IES Document:<sup>7</sup>

Lighting Handbook

2.7 NFPA Standards:<sup>8</sup>

NFPA 49 Fire Protection Guide to Hazardous Materials

NFPA 53 Recommended Practice on Materials, Equipment and Systems Used in Oxygen-Enriched Atmospheres

NFPA 55 Compressed Gases and Cryogenic Fluids Code

NFPA 68 Guide for Venting of Deflagrations

NFPA 70 National Electrical Code

NFPA 70E Standard for Electrical Safety in the Workplace (Includes Arc-Flash)

NFPA 79 Electrical Standard for Industrial Machinery

NFPA 86 Standard for Ovens and Furnaces

NFPA 91 Standard for the Installation of Blower and Exhaust Systems

NFPA 480 Standard for Storage and Handling of Magnesium

NFPA 484 Standard for Combustible Metals

2.8 Occupational Safety and Health Administration:<sup>9</sup>

29 CFR 1910 Code of Federal Regulations, Part 1910 General Industry

29 CFR 1910.23 Walking-Working Surfaces

29 CFR 1910.94(a) Ventilation—Abrasive Blasting

29 CFR 1910.145 Specification for Accident Prevention Signs and Tags

29 CFR 1910.146 Permit-Required Confined Spaces

29 CFR 1910.147 Control of Hazardous Energy (Lockout/Tagout)

29 CFR 1910.184 Slings

29 CFR 1910.215 Abrasive Wheel Machinery

29 CFR 1910.217 Mechanical Power Presses

29 CFR 1910.331–335 Electrical Safety-Related Work Practices

OSHA Instruction STD 1-12.8 October 30, 1978 (Program Directive #100-39) Subject: 29 CFR 1910.215(a)(4) Abrasive Wheel Machinery—Work Rests

NOTE 1—State plan states may have their own regulations.

2.9 American Foundry Society (AFS):<sup>10</sup>

Guide for Selection and Use of Personal Protective Equipment and Special Clothing for Foundry Operations Managing the Foundry Indoor Air Environment

Foundry Health and Safety Guides

### 3. Terminology

3.1 For definitions of terms used in this standard, see Terminology E1542.

3.2 Definitions:

3.2.1 *adjustable barrier guard*, *n*—physical barrier with adjustable sections that is designed to prevent entry of any part of the body into the hazard zone by reaching through, over, under, or around the barrier.

3.2.2 *arc furnace*, *n*—see *direct arc furnace* and *indirect arc furnace*.

3.2.3 *bail/spreader*, *n*—hoop or arched connection between the crane hook and ladle or between crane hook and ladle trunnions.

3.2.4 *blast*, *n*—in foundry operations, air or oxygen-enriched air that is blown, under pressure, into a cupola for supporting combustion.

3.2.5 *blast compartment*, *n*—that portion of the blasting enclosure that contains the blasting media propulsion device.

3.2.6 *blow plate*, *n*—plate affixed to the magazine or blow head of a core- or mold-blowing machine having holes or slots through which sand or other media in the magazine or blow head passes into the core or mold cavity or around the pattern when air or other gas pressure is applied to the machine.

3.2.7 *bottom discharge (pour, tap) ladle*, *n*—ladle that has its molten metal contents discharged through an opening in the bottom.

3.2.8 *channel furnace*, *n*—electric induction furnace in which heat is electrically induced in the metal in a refractory channel.

3.2.9 *charge*, *n*—in foundry operations, material introduced into a melting furnace for the production of molten metal.

3.2.10 *core*, *n*—in foundry operations, preformed aggregate or collapsible insert placed in a mold to shape the interior or that part of a casting that cannot be shaped by the pattern.

3.2.11 *core binder(s)*, *n*—any material, liquid or solid, which is used to bond core aggregates.

3.2.12 *corebox*, *n*—a (wood, metal, or plastic) structure, the cavity of which has the shape of the desired core that is to be made therein.

3.2.13 *coreless furnace*, *n*—electric induction furnace consisting of an induction coil surrounding a crucible or refractory lining in which metal is melted or molten metal is retained.

<sup>10</sup> Available from the American Foundry Society, 1695 N. Penny Lane, Schaumburg, IL 60173.

<sup>5</sup> Available from Compressed Gas Association (CGA), 14501 George Carter Way, Suite 103, Chantilly, VA 20151, <http://www.cganet.com>.

<sup>6</sup> Available from International Association of Plumbing and Mechanical Officials, 4755 E. Philadelphia St., Ontario, CA 91761, <http://www.iapmo.org>.

<sup>7</sup> Available from Illuminating Engineering Society (IES), 120 Wall Street, New York, NY 10005-4001, <http://www.ies.org>.

<sup>8</sup> Available from National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA 02169-7471, <http://www.nfpa.org>.

<sup>9</sup> Available from Occupational Safety and Health Administration (OSHA), 200 Constitution Ave., NW, Washington, DC 20210, <http://www.osha.gov>.

3.2.14 *core- or mold-blowing or shooting machine*, *n*—machine for injecting sand or other media into the core or mold cavity by means of compressed air or other gas.

3.2.15 *crane ladle*, *n*—ladle handled by an overhead crane.

3.2.16 *crucible*, *n*—in foundry operations, container used for the melting, holding, and pouring of metal.

3.2.17 *cupola*, *n*—in foundry operations, vertical shaft-type furnace for melting and/or producing molten metal by combusting coke or other fuels using a blast, and possibly additional pure oxygen, that is introduced through the cupola tuyeres.

3.2.18 *cupola drop*, *n*—materials dropped from the cupola at the end of a heat.

3.2.19 *direct arc furnace*, *n*—furnace in which heat is produced by an electric arc between electrodes and the charge.

3.2.20 *drop area*, *n*—in foundry operations, the area directly under the cupola that receives the hot bed coke or other hot materials from the inside of the furnace when the bottom doors or side access door are opened.

3.2.21 *drop zone*, *n*—the zone adjacent to the drop area that is exposed to drop hazards during the dropping process.

3.2.22 *dross*, *n*—metal oxides or foreign matter, or both, that accumulates on the surface of nonferrous molten metal.

3.2.23 *finishing*, *v*—in foundry operations, attainment of a desired surface finish or finish characteristics by such means as abrasive impingement, grinding, or polishing.

3.2.24 *flask*, *n*—in foundry operations, container, without top or bottom, used to contain the sand or other media while it is being formed. It is made in two or more parts, the lower part called the drag and the upper part called the cope. Intermediate sections, if any, are called cheeks.

3.2.25 *flask lifting device*, *n*—chains, rods, bails, cables, slings, and other materials used to support a load such as a flask for turning, inverting, or transporting.

3.2.26 *gas handling system*, *n*—the collective group of equipment that draws cupola gas from the furnace.

3.2.27 *heat*, *n*—in foundry operations, stated weight of metal obtained from a period of melting in a cupola or furnace or the time required to melt and process this material.

3.2.28 *indirect arc furnace*, *n*—furnace in which heat is produced by an electric arc between electrodes.

3.2.29 *induction furnace*—see *channel furnace* and *coreless furnace*.

3.2.30 *ladle handler*, *n*—mechanism used to suspend, transport, raise and/or lower a ladle.

3.2.31 *ladle pouring stand*, *n*—structural device for supporting or tilting a ladle, or both.

3.2.32 *lance, oxygen*, *n*—device consisting of steel pipe, tubing, oxygen source, and controls.

3.2.32.1 *Discussion*—Frequently used to open frozen tap or slag holes; also occasionally to oxidize impurities in molten metal bath.

3.2.33 *lip*, *n*—in foundry operations, formed “U” or “V” depression in a molten metal outlet to confine the stream.

3.2.34 *main burner*, *n*—primary combustion device commonly ignited by a secondary source.

3.2.35 *mold*, *n*—in foundry operations, form that contains the cavity into which molten metal is poured to produce a casting of definite shape and outline.

3.2.36 *molding machine*, *n*—mechanical device for compacting molding media (usually sand) about the pattern(s), thus forming the mold.

3.2.37 *moving frame*, *n*—that part of a molding machine that supports the flask and imparts the motions necessary to the mold making process.

3.2.38 *muller*, *n*—machine that blends, coats, kneads, or mechanically combines various sand(s) or other media used for foundry purposes with binders and other additive agents.

3.2.38.1 *Discussion*—Typically, it consists of a circular container in which rotating plows or mill wheels (mullers), or both, are mounted.

3.2.39 *pattern*, *n*—in foundry operations, form of wood, metal, or other material against which molding material is compacted to make a mold for casting metals.

3.2.40 *pouring*, *n*—in foundry operations, final transfer of molten metal before its solidification into its intended form.

3.2.41 *pouring area*, *n*—location in a foundry where molten metal is poured into molds or transferred from a ladle to a furnace.

3.2.42 *qualified engineer*, *n*—one who possesses an engineering degree from an accredited institution of higher learning or a certificate of professional standing and has engineering experience with the kind of work and equipment involved.

3.2.43 *qualified person*, *n*—individual determined by the employer to have the training and experience to safely operate or maintain the equipment involved.

3.2.44 *reactive metal*, *n*—any metallic element or alloy that is readily oxidized with the release of large quantities of heat.

3.2.45 *runout pit*, *n*—chamber placed below or in front of a furnace, or both, to receive molten material in an emergency.

3.2.46 *sand mixer*, *n*—machine for conditioning mold and core sand by controlled mixing with additives.

3.2.47 *sand muller*, *n*—machine for conditioning mold and core sand by controlled mixing with additives.

3.2.48 *sand system*, *n*—that part of a foundry installation that processes and transports sand or other media in bulk form.

3.2.49 *screen (sand)*, *n*—sieve or riddle with openings of definite size used to separate one grain size from another or to remove lumps and foreign objects from sand.

3.2.50 *skimming*, *n*—in foundry operations, removing slag or dross from the surface of the molten metal.

3.2.51 *skip hoist*, *n*—basket, bucket, or other container that is drawn or elevated on rails by a pulling or pushing action.

3.2.52 *slag*, *n*—nonmetallic byproducts and contaminants generated during the melting, transferring, and holding of molten metal.

3.2.53 *slagging*, *v*—see *skimming*.

3.2.54 *slag hole or door*, *n*—opening in the furnace through which slag is removed.

3.2.55 *slinger*, *n*—machine that throws sand or other media into a flask, corebox, or other container.

3.2.56 *tapping*, *v*—in *foundry operations*, removing molten material from the furnace by opening a tap hole.

3.2.57 *transfer car*, *n*—in *foundry operations*, vehicle used for transporting vessels or material(s), usually in a fixed path.

3.2.58 *trunnions*, *n*—shafts used to support, turn, or tilt a vessel.

3.2.59 *tumbling barrel*, *n*—power-driven rotating drum or barrel in which castings are cleaned or polished, or both. The castings act as abrasives for each other or are tumbled in an abrasive media.

3.2.60 *tuyere*, *n*—nozzle opening through which the blast enters a cupola.

#### 4. Materials and Manufacture

4.1 *Responsibility*—It shall be the responsibility of any person purchasing, constructing, reconstructing, or modifying any equipment covered by this practice to:

4.1.1 Design, construct, and modify equipment in accordance with the provisions of this practice. (Consider other applicable safety standards.)

4.1.2 Select and include in construction only components that have a working rating equal to or greater than that required to meet the maximum recommended operating condition(s).

4.1.3 Furnish printed instructions with each unit of equipment. (To minimize hazards, it is essential that this material be readily available to maintenance, operations, and engineering personnel.) The instructions shall include:

4.1.3.1 Engineering drawings and other materials required to install and place such equipment into operation properly.

4.1.3.2 Operating and maintenance instructions as specified in Section 5.

4.1.3.3 Spare parts lists.

4.1.3.4 Procedures in accordance with hazardous energy control (6.5) standard shall be followed.

4.1.4 Hazard alert signs, when used, shall comply with the following standards: ANSI Z535.1, ANSI Z535.2, ANSI Z535.3, ANSI Z535.4, and ANSI Z535.5.

4.1.5 Apply a legible identification plate to each piece of equipment. This plate shall include, as a minimum, the manufacturer's name, equipment type or model identification, or both, serial number, and rated capacity(s).

4.1.6 Ensure that any modification(s) or alteration(s) to a piece of equipment or machinery covered by this practice that result in a change from the manufacturer's original design or intended method of operation, or both, shall be done under the supervision of a qualified engineer and shall comply with mandatory safety standards for that given category of equipment. An additional legible identification plate shall be at-

tached to the machine or equipment adjacent to the manufacturer's original identification plate (see 4.1.5). The new identification plate shall state the date the modification(s) was made and the person or organization responsible. (Restrictions on modifications or alterations are not intended to bar repair or maintenance, including the substitution of substantially equivalent components.)

#### 4.2 Inherent Hazards:

4.2.1 *Hazards to Personnel Associated With Moving Parts*—Hazards to personnel associated with moving parts (other than point of operation hazards) shall be guarded in accordance with ANSI B15.1 or ASME B20.1, as appropriate.

NOTE 2—Some examples of hazards to personnel associated with moving parts are:

(1) Rotating components, such as flywheels, gears, sheaves, and shafts in proximity to personnel;

(2) Run-in pinch points, such as meshing gears, belts, and chains; and

(3) Pinch points between the moving and stationary components of the machine.

4.2.1.1 *Responsibility – Manufacturer*—The manufacturer shall endeavor to eliminate the hazards by design or provide protection against them. When hazards cannot be eliminated by design or protection, the manufacturer shall warn against them by using signs in accordance with ANSI Z535.1, ANSI Z535.2, ANSI Z535.3, ANSI Z535.4, and ANSI Z535.5, as appropriate.

NOTE 3—Together, these five ANSI standards contain information needed to specify formats, colors, and symbols for safety signs used in environmental and facility applications, product applications, and accident prevention signs.

4.2.1.2 *Responsibility – Employer*—Equipment with moving parts that could cause injuries to personnel shall be guarded.

4.2.2 *Hazards to Personnel Associated With the Point of Operation*—Refer to Section 6.

4.2.3 *Hazards to Personnel Associated With Broken, Falling, or Flying Equipment Components*—The manufacturer shall design, secure, or cover machine components to minimize hazards caused by falling or flying components resulting from loosening or breakage.

#### 4.3 Installation:

4.3.1 *Employer Responsibility*—The employer shall be responsible for safe conditions for installing the equipment covered by this practice.

4.3.2 *Safeguarding During Construction, Reconstruction, or Modification*—Use of barriers, shields, and covers over excavations, pits, or tanks shall be required and used. Means shall be provided to prevent unauthorized persons from entering an area or zone in which construction or repair is in progress.

NOTE 4—ANSI/ASSP A1264.1 contains the appropriate requirements and recommendations.

4.3.3 *Workstation*—Each workstation shall have space to permit work without physical interference from equipment or another employee(s) within that workstation. Services, including electric power, air hydraulic, water, steam, or process liquids, shall be delivered in identified conductors with shutoff

valves or disconnecting means legibly marked, and shall be visible and accessible.

**4.4 Power Requirements:**

**4.4.1 Disconnect Means**—All motors, motor circuits, and controllers shall have disconnecting means as required by Article 430 of the National Electric Code (NFPA 70). The disconnecting means shall be capable of being locked in the (OFF) position.

**4.4.1.1 Disconnect Means Identification**—Each disconnect means shall be marked with a legible, durable label that identifies the voltage and equipment controlled. Identification shall be verified at time of installation.

**4.4.1.2 Disconnection:**

(1) Control circuits shall be so arranged that they will be disconnected from all sources of power when disconnecting means is in the open (OFF) position.

(2) There shall be an interlock, on separate power source feeds, that opens when the main disconnect is opened.

(3) The disconnecting means consists of two or more separate devices, one of which disconnects the motor and the controller from the source(s) of power supply for the motor, and the other disconnects the control circuit(s) from its power source. Where separate devices are used, they shall be located immediately adjacent, one to the other.

**4.4.1.3 Disconnection Hazards**—Where the operation of a disconnecting means could create a hazard, a suitable hazard alerting nameplate shall be provided and located adjacent to the label required in 4.4.1.1

**4.4.1.4 Motor-Starting Equipment**—Motor-starting equipment with the potential to restart a motor automatically after an unplanned power interruption or power outage shall not be used when automatic restarting would potentially result in injury to personnel. It shall be necessary to restart the motor manually.

**4.4.2 Electrical Power Off – Electrical Panels or Electrical Furnaces:**

**4.4.2.1 Disconnect Means**—All control and power circuits shall be equipped with disconnecting means that have the capability to be locked in the open (OFF) position for the protection of the operating or maintenance personnel.

**4.4.2.2 Isolation (Disconnect) Switches**—Isolation switches not capable of interrupting load current shall not be opened under load and shall be provided with signage warning against opening under load.

**4.4.2.3** Where possible, these isolation switches shall be key interlocked with the circuit-interrupting device so that the isolation switch cannot be opened under load. Individual consideration shall be given to keep these switches in a locked closed (ON) condition during normal operation.

**4.4.2.4 Door Interlock**—All doors providing access to electrical circuits that operate at over 50 V shall be interlocked to disconnect electrical power when the door is opened. If voltages in excess of 50 V remain after electrical power has been disconnected, hazard alert signs shall be provided.

**4.4.2.5** While power has been disconnected when the door is opened, electrical power remains at the primary terminals. In addition, in some instances capacitors will remain charged and must be discharged to remove all voltage from the circuits inside the cabinet.

**NOTE 5**—Considerations for arc flash should be taken into account (NFPA 70E).

**4.4.3 Fluid Power Off**—Means shall be provided for isolating fluid (air, oil, or other) energy sources from a machine, or group of machines, controlled as a system. These means shall have provisions for being locked in the isolating mode. Pressure buildup on the machine side port of the isolating means shall be eliminated by positive means such as venting to atmosphere or drainage to tank.

**4.5 Electrical Ground Faults:**

**4.5.1 Grounded Control Circuit**—When one side of the control circuit is grounded, the control circuit shall be designed so that an accidental ground will not start a motor, energize any component, or cause a machine movement.

**NOTE 6**—Circuits that have all coils or solenoid(s) common to the grounded side of the control circuit, without intervening contacts, will almost always meet these requirements on a circuit that is grounded. It is possible that circuits that do not have this characteristic are hazardous in that an accidental ground might cause unwarranted energization or machine movement, or both.

**4.5.2 Ungrounded Control Circuit**—Ungrounded control circuits shall have operative ground-indicating lights. An indicated ground shall be reported at once by the employee and investigated immediately. If a personnel hazard exists, corrections shall be made before resuming operation of the equipment.

**NOTE 7**—Without grounds, each light has only one half voltage and both lights are therefore equally dim—the normal condition. A ground causes one light to glow brightly, the other to dim or go out. Depending upon the location of the accidental ground, this indication is usually either constant or intermittent during operations. In an ungrounded system, it is not clear whether the first accidental ground will indicate a personnel hazard possible with the second accidental ground—or with simultaneous double accidental grounding. For instance, a ground on the common coil side of the control circuit will, in effect, merely convert the ungrounded circuit into a grounded circuit. The remarks in 4.5.1 and **Note 6** are then applicable. However, where the first accidental ground is on the contact side, it could possibly create a personnel hazard. This potential hazard must be resolved by authorized personnel.

**4.6 Fluid Power Off**—Means shall be provided for isolating fluid (air, oil, or other) energy sources from a machine, or group of machines, controlled as a system. These means shall have provisions for being locked in the isolating mode. Pressure buildup on the machine side port of the isolating means shall be eliminated by positive means such as venting to atmosphere or drainage to tank.

**4.7 Electrical Equipment Grounding**—All electrical equipment shall be grounded in accordance with the National Electrical Code.

**4.8 Fluid Exhaust (Gas or Liquid)**—The employer shall be responsible for arranging conductors to direct the exhaust of fluids to a location(s) that will not create a hazardous condition.

## 5. Care of Equipment – General Provisions

### 5.1 Instructions:

5.1.1 *Manufacturer*—The manufacturer shall furnish operating and maintenance instructions with equipment covered by this practice. These shall be in conformance with hazardous energy control (6.5).

NOTE 8—Most operating and maintenance manuals provide specific instructions to aid in the proper operation and maintenance of the equipment. Optional means to provide adequate instructions include written, illustrated, audio, and visual recorded material. However, the employer is responsible for making sure all equipment is adequately guarded and safe for operation.

5.1.2 *Modification/Reconstruction*—Any person modifying or reconstructing any piece of equipment covered by this practice shall furnish operating and maintenance instructions, including updated functional engineering drawings of controls covering the modified portion of the equipment. Refer to Section 4.

NOTE 9—Many modification and rebuilding efforts are so extensive that the original instructions from the manufacturer are incorrect or meaningless.

5.1.3 *Employer*—The employer shall specify corrective maintenance procedures for the equipment covered by this practice that minimize hazards to operating and maintenance personnel.

5.2 *Installation*—The employer shall provide work areas around the equipment covered by this practice to minimize hazards to operating and maintenance personnel.

5.3 *Inspection and Preventive Maintenance*—The employer shall establish and supervise a program of documented inspections and preventive maintenance of the equipment covered by this practice. Designated personnel shall perform the required inspections and maintenance.

5.3.1 The frequency of inspecting the equipment is based on the manufacturer's recommendations, the number of hours used per month, the maintenance history, and regulatory requirements. The employer shall schedule frequent or periodic inspections, or both, that would reveal hazards caused by age, overloading, corrosion, fatigue, improper use, or improper installation.

5.4 *Maintenance Personnel Training and Experience*—The employer shall provide trained and competent personnel for maintaining the equipment covered by this practice.

5.4.1 Competent maintenance personnel shall have the technical background necessary to understand the information contained in the maintenance manuals for the machine they are inspecting or maintaining.

### 5.5 Startup Procedures:

5.5.1 *Manufacturer*—The manufacturer shall recommend a startup procedure that minimizes hazards.

5.5.2 *Employer*—The employer shall establish and follow a startup procedure considering the manufacturer's recommendations before any equipment covered by this practice is placed in regular operation.

5.5.3 *Employee*—The employee shall follow the startup procedure established by the employer.

### 5.6 Shutdown Procedure:

5.6.1 *Manufacturer*—The manufacturer shall recommend a shutdown procedure that minimizes hazards.

5.6.2 *Employer*—The employer shall establish and follow a shutdown procedure considering the manufacturer's recommendations for necessary lockouts before allowing any inspection, adjustments, or maintenance of the equipment covered by this practice.

5.6.3 *Employee*—The employee shall follow shutdown, lockout, and safeguarding procedures established by the employer.

### 5.7 Troubleshooting, Maintenance, and Repair:

5.7.1 *Employer*—The employer shall provide training for employees engaged in troubleshooting, maintenance, or repair in isolated or hidden areas. For work in confined spaces, entry procedures shall be in conformance with 29 CFR 1910.146.

5.7.2 *Employee*—The employee shall use the monitoring means established by the employer to inform others of his or her presence when performing maintenance or setup work in hidden or isolated areas.

5.7.3 *Physical Entry Into Machine or Equipment*—The employee shall follow established lockout/tagout and confined space procedures for the machine or equipment before physical entry.

NOTE 10—It is possible that the rules for confined space or permit-required confined space, or both, will also apply.

5.7.4 *Troubleshooting, Maintenance, and Repair With Power On*—Exception for qualified persons only: When necessary to locate and define problems and make adjustments with power on, qualified persons are allowed to perform work on machines or equipment with guards removed or within areas protected by barriers, if protective measures have been taken to train and supervise the employees to not place any part of the body in the path of any movable machine or equipment member or in contact with any hazardous energized electrical equipment. Employees shall follow OSHA regulations 29 CFR 1910.331, 29 CFR 1910.332, 29 CFR 1910.333, 29 CFR 1910.334, and 29 CFR 1910.335.

5.7.5 *Defeating Protective Devices*—No employee other than authorized and qualified personnel performing special maintenance shall remove, bypass, or alter any device that was provided to reduce hazardous conditions.

5.7.5.1 This practice does not condone defeating any protective device at any time. This practice does, however, recognize that maintenance conditions exist when authorized maintenance personnel would be permitted to bypass the protective device. Under such conditions, 5.7.4 shall be strictly followed.

5.7.6 *Returning Equipment to Production*—The employee shall verify that the machine or equipment has all guards secured in place and operators have been informed before releasing it for production use.

## 6. Safeguards – General Requirements

### 6.1 Responsibility for Safeguarding:

NOTE 11—It must be understood that in the application of this practice, there are responsibilities incumbent upon the employer, the manufacturer, the installer, and the operator of foundry equipment. (See ANSI B11.6,

ANSI B11.9, and ANSI B11.TR3 on hazard analysis and risk assessment.) Some safety features are incorporated in the design of the equipment. Some protection depends on installation after assembly of the associated components in the field. Some safety features are a part of a building or structure and are not an integral part of the components themselves. Some protection depends on the operation and maintenance by the employer and operators. Some protection depends on training and supervision.

6.1.1 *Manufacturer*—The manufacturer of equipment shall furnish equipment that is safe for the intended use as indicated by the employer.

6.1.2 *Employer*—The employer shall be responsible for the installation and maintenance of guards, shields, or barriers and for maintaining the condition and position of such devices to protect against recognized hazardous conditions. The employer shall be responsible for providing, installing, and maintaining any additional guards required to provide protection against recognized hazardous conditions created by the use or installation, or both, of the equipment.

6.2 *Guarding*—Potential hazards including, but not limited to, nip, pinch, shear, puncture, catching points, or a combination thereof shall be guarded.

6.2.1 The guard openings shall be in conformance with **Table 1**.

6.2.1.1 Manual operation, such as placing copes on drags, manually closing molds, with or without mechanical assists, shall be excluded from mandatory guarding where variable conditions preclude the use of barriers or devices. For these operations, special emphasis shall be given to operator training.

6.2.1.2 *Guarding by Location*—Hazards that are inaccessible due to height or distance shall be considered to be guarded by location or position. However, when work is performed in the vicinity of the hazard, either guarding or hazardous energy control (6.5) applies.

6.3 *Hazard Zone Guarding:*

NOTE 12—Refers to guarding within that area of the operator’s work zone where the work process is being performed.

6.3.1 *Hazard Zone Guard(s)*—Every hazard zone guard shall meet the following design, construction, application, and adjustment requirements:

6.3.1.1 It shall prevent entry of any part of the body into the hazard zone by reaching through, over, under, or around the guard.

6.3.1.2 It shall be in conformance with the maximum permissible openings shown in **Table 1**.

6.3.1.3 It shall not create pinch points.

6.3.1.4 It shall not be readily removable.

6.3.1.5 It shall offer maximum visibility of the equipment operation consistent with the other requirements.

6.3.1.6 It shall be inspected at intervals as outlined in ANSI B11.6 and ANSI B11.9 standards.

6.3.2 *Barrier Guard(s)*—Barrier guards shall meet the following criteria:

6.3.2.1 Prevent bodily entry into the process pinch or shear point by reaching through, over, under, or around the guard during the production cycle;

6.3.2.2 Conformance with the maximum permissible openings shown in **Table 1**;

6.3.2.3 In itself create no pinch point between the guard and moving machine parts;

6.3.2.4 Use fasteners not readily removable by the operator so as to minimize the possibility of misuse or removal of essential parts;

6.3.2.5 Be readily inspected for its effectiveness;

6.3.2.6 Offer maximum visibility of the hazard zone consistent with the other requirements; and

6.3.2.7 Be free of sharp edges, burrs, and so forth, which could be a hazard.

6.3.3 *Fixed Barrier Guards*—A fixed barrier guard, when used, shall meet the criteria of 6.3.1.1 – 6.3.1.6 and shall be attached securely.

NOTE 13—Addition of an interlock to a fixed barrier guard does not necessarily make this an interlocked barrier guard.

6.3.4 *Interlocked Barrier Guards*—An interlocked barrier guard, when used, shall meet the requirements of 6.3.1.1 – 6.3.1.6 and shall be interlocked with the machine power or controls so that the machine will not operate unless the hinged or movable section of the guard is in the closed position(s).

6.3.4.1 If the interlock device is used as an alternative measure for hazardous energy control (6.5), an authorized employee shall inspect the interlock device at the beginning of each shift of operation and immediately report any damage or malfunction of the device to the supervisor. If an interlocking device is found to be defective, the machine shall not be put into operation until repaired and re-checked.

NOTE 14—The hinged or removable section(s) of this guard are intended for use when frequent access is required.

6.3.5 *Adjustable Barrier Guards*—An adjustable barrier guard shall be securely attached and shall meet the criteria of 6.3.1.1 – 6.3.1.6.

6.3.5.1 This type of guard requires close supervision of use and adjustment, or inadequate protection could result. It shall be the responsibility of the employer to establish and follow a program of periodic and regular inspection of power press and auxiliary equipment. Refer to 29 CFR 1910.217(e).

NOTE 15—The adjustable sections allow different jobs to be run on the equipment.

**TABLE 1 Accepted Safe Opening Between Guard and Hazard Zone<sup>A</sup>**

Distance of Opening from Hazard Zone		Maximum Width of Opening	
(in.)	(mm) <sup>B</sup>	(in.)	(mm) <sup>B</sup>
½ – 1½	13–38	¼	6
1½ – 2 ½	38–64	⅜	10
2½ – 3½	64–89	½	13
3½ – 5½	89–138	⅝	16
5½ – 6½	138–165	¾	19
6½ – 7½	165–191	⅞	22
7½ – 12½	191–318	1¼	32
12½ – 15½	318–394	1½	38
15½ – 17½	394–445	1⅞	48
17½ – 31½	445–800	2⅞	54

<sup>A</sup> Source: 29 CFR 1910.217 Table O-10.

<sup>B</sup> Approximate.



6.3.6 *Hazard Warning*—Where it is not feasible to guard against the hazard, or where the guard itself creates a hazard, the potential hazard shall be marked prominently to warn of its existence.

6.4 *Hazard Zone Protective Devices*—A hazard zone device shall be provided to protect the operator and other personnel in the area by:

6.4.1 Preventing or stopping the equipment motion or condition that would create a hazard or pinch point if any portion of the body is in the hazard zone;

6.4.2 Preventing personnel from inadvertently reaching into the hazardous motion that has started or been initiated;

6.4.3 Requiring personnel to position all parts of the body away from possible hazardous conditions and position both hands on initiators during the period of time when the possibility of pinching motions or hazardous conditions is present;

6.4.4 Requiring personnel to move away from the area of possible hazardous conditions and activate an initiator at a remote location (hostage control—see 6.4.7); or

6.4.5 The employer shall be responsible for enforcing a rule that actuation of equipment controls be made only by the operator. An operator shall not be assisted by another employee operating the equipment controls.

NOTE 16—Hazard zone protective devices do not offer the degree of protection provided by a guard. These devices are secondary protection and it is permissible to use them alone or in multiples to create the greater degrees of protection.

6.4.6 *Presence-Sensing Hazard Zone Device*—A presence-sensing hazard zone device, when used, shall protect the operator by deactivating the machine or equipment motion when the presence of personnel is detected in the hazard zone.

NOTE 17—These devices are necessarily secondary protection. Their value is dependent upon their correct adjustment and maintenance.

6.4.6.1 This device shall not be installed, connected, or used in a manner that could create any hazard to the operator.

6.4.6.2 This device shall not be used as an initiator of any motion or function being protected by the device. Where or when the device is used to prevent the closing of a machine on an operator's body part, withdrawal of the operator's hands shall not automatically restart the cycle.

6.4.6.3 To the extent permitted by current recognized design techniques, this device shall be designed and applied so that any malfunction or failure of the device would prevent or stop the function or motion in the area being protected by the device.

NOTE 18—Although there is much talk about “fail-safe,” there cannot be such an absolute condition. Single failures of device components result in stopping or prevent initiation.

6.4.6.4 This device shall be installed, adjusted, and maintained only by authorized competent personnel.

NOTE 19—These devices are necessarily secondary protection. Their value is dependent upon their correct adjustment and maintenance.

6.4.7 *Hostage Controls*—Hostage controls shall be one or more of the following types of initiators:

6.4.7.1 *Two-Hand-Maintained Initiators*—A two-hand-maintained initiator shall be designed, installed, and connected to protect the operator by requiring application of both of the operator's hands to the machine operating initiators until the hazardous portion of the cycle is completed and shall be equipped with anti-tiedown features. Each hand control shall be protected against unintended activation and arranged by design, construction, or separation, or a combination of the three, so that the concurrent use of both hands is required to initiate the equipment.

6.4.7.2 *Two-Hand Momentary Initiators*—A two-hand momentary initiator shall protect the operator by requiring that the single-cycle initiators be operated at a position so that the operator cannot reach into the hazard zone during the hazardous portion of the cycle. Two-hand momentary initiators shall be equipped with anti-tiedown feature. Each hand control shall be protected against unintended activation and arranged by design, construction, or separation, or a combination of the three, so that the concurrent use of both hands is required to initiate the equipment.

6.4.7.3 *Single-Maintained or Momentary Initiator*—A single-maintained or momentary initiator shall protect the operator by permanently locating the single-cycle operating initiator remote from the hazard zone so that the machine completes its hazardous portion of the cycle before the operator has a chance to place any part of his or her body into the hazard zone. Single-maintained or momentary initiators shall be protected against unintended activation.

NOTE 20—Examples of this type of initiator include push-button, foot switch, knee switch, and so forth. Foot switches on mechanical connectors do not meet this requirement.

6.4.7.4 *Additional Initiators*—In an operation requiring more than one operator, separate hostage controls shall be provided for each operator.

6.4.7.5 Hostage controls must be located so that inadvertent entry into pinch points by parts of the body is prevented. The possibility of stumbling, slipping, or fatigue must be considered in control placement.

NOTE 21—It is acceptable to class hostage controls as a guard device if their location provides unimpeded access and visibility for the operator to the hazard zone and they are located so that possible pinch points or hazardous conditions cannot be reached.

6.4.8 *Hand-Positioning Tools*—Hand-positioning tools shall not be used in place of guards or protective devices.

NOTE 22—Hand-positioning tools such as pliers, tongs, forceps, and specially designed devices are commonly used for placing, positioning, or moving materials into or away from hazardous locations.

6.4.9 *Stop Block – Manual*—A manual stop block shall be used to eliminate potential pinch points where setup or maintenance work necessitates exposure of personnel in the hazard zone.

6.4.10 *Stop Block – Mechanical*—The use of mechanical stop block devices in place of hazard zone protective devices is acceptable. When used, it shall stop a motion that might cause injury or create a hazardous condition and be able to withstand the forces to which it is subjected.

6.4.10.1 A mechanical stop block device shall, in itself, create no pinch points between the device and equipment parts.

6.4.10.2 It shall use fasteners not readily removable by the operator.

6.4.10.3 An authorized person shall inspect the device daily and immediately report any damage or malfunction of the device to their supervisor.

6.5 *Hazardous Energy Control*—For maintenance or non-routine activities where guarding of hazards is not present or when guarding is removed, employees shall be protected by the provisions of 29 CFR 1910.147 Control of Hazardous Energy (Lockout/Tagout) or ANSI/ASSP Z244.1 Control of Hazardous Energy Lockout, Tagout, and Alternative Methods.

## 7. Operation of Equipment – General Requirements

### 7.1 *Employer's Responsibility:*

7.1.1 *Training Operators*—The employer shall train all operators to perform their assigned functions in a manner that will minimize hazards. The training shall include familiarization of the operators with the provisions of this practice that relate to their assigned functions. Operator(s) shall demonstrate to the employer competence to perform the assigned function before starting work on any operation. (See ANSI/ASSP Z490.1.)

7.1.1.1 Give special attention to non-English-speaking operators. In some cases, the use of translations is required. Machine instruction manuals need to be explained and made available to operators and maintenance employees.

7.1.2 *Supervision*—The employer shall enforce established operating procedures.

7.1.2.1 For those employees who disregard safety rules and correct operating procedures, disciplinary measures shall be used and documented.

7.1.2.2 *Actuation of Equipment Controls*—The employer shall be responsible for enforcing a rule that actuation of equipment controls be made only by authorized and qualified personnel.

7.1.3 *Work Area*—Space shall be maintained in each work area so that movement of one operator will not interfere with the work of others. The floor area of the operator's work area shall be maintained and free of obstructions. Housekeeping procedures shall be established to minimize the accumulation of grease, oil, water, and abrasive blasting material.

NOTE 23—For additional information regarding walking and working surfaces, refer to ANSI/ASSP A1264.1.

7.1.4 *Overloading*—The employer shall require that machines and equipment be operated within the posted capacity ratings.

7.1.5 *Personal Protective Equipment (PPE)*—Based on the hazard assessment, the employer shall specify the personal protective equipment required to perform work functions. The employer shall enforce the proper use of this equipment.

7.1.6 *Emergency Equipment*—Suitable facilities for quick drenching or flushing of eyes and body shall be provided within the work area for immediate emergency use in the event of personal contact with injurious corrosive materials.

### 7.2 *Employee's Responsibility:*

7.2.1 It shall be the responsibility of the employee(s) to:

7.2.1.1 Follow all safety practices and procedures specified for the functions for which they are responsible.

7.2.1.2 Notify their supervisor when they observe unsafe practices or conditions. They shall immediately report any damaged, missing, or malfunctioning guards.

7.2.1.3 Use personal protective equipment as specified by the employer in the PPE hazard assessment.

7.2.1.4 Refrain from wearing such clothing or jewelry as will be hazardous to personal safety.

NOTE 24—When working around moving parts of machines or equipment, loose clothing, neckties, finger rings, necklaces, watch bands, body ornaments, long hair, and beards constitute potential hazards.

7.2.1.5 Maintain an orderly work area.

7.2.1.6 Not alter, remove, or disable safety equipment.

7.2.1.7 Never initiate a motion that could cause injury or damage.

7.2.1.8 Never blow, throw, or move material to create a hazard for other personnel.

7.2.1.9 Never remove a lock placed by other personnel.

7.2.1.10 Never alter, block, deface, or obliterate any sign, notice, or advisory plate that relates to equipment.

7.2.1.11 An operator shall not perform adjustments, make equipment changes, or perform maintenance unless trained and authorized by the employer. Authorized maintenance shall be performed in accordance with Section 5.

## 8. Sand Preparation, Molding, and Core Making

### 8.1 *Sand Handling and Preparation:*

8.1.1 *Silos, Hoppers, and Bins*—Silos, hoppers, and bins are confined spaces and it is possible that they are also permit-required confined spaces. Entry procedures shall be in conformance with 29 CFR 1910.146 and hazardous energy control (6.5) procedures.

8.1.2 *Gates (Closures)*—All nip or pinch points, or both, of gates (closures) in silos, bins, and hoppers shall be guarded with barrier guards or by location.

8.1.3 *Dislodging Material*—Safe work practices shall be developed to prevent injury when employees must dislodge clinging or bridged material with a mallet or other instrument in one hand while actuating the gate (closure) with the other hand. Guarding against contact between the operator's body (hands primarily) and pinch or nip points, or both, is the intent of this section.

8.1.4 *Gate (Closure) Actuators*—Guards, shields, chutes, remote actuating devices, or a combination of thereof, for gates (closures) on silos, hoppers, and bins shall be installed to prevent the employee from being directly in the path of material being discharged.

8.1.5 *Conveyors, Bulk Material, Elevators, and Turntables*—Equipment shall be installed that complies with mandatory safety standards for that given category of equipment.

NOTE 25—Consider overhead spill pans under conveyors, crossing walkways, or work areas.

8.1.6 *Screw or Flight Conveyors, Screens, Coolers, Agitators, and Blenders*—Guards shall be installed to prevent entry of persons or reaching into vessels or equipment with internal moving members

8.1.7 *Mullers and Mixers*—The blending area of mullers and mixers of sand or other materials shall be fully guarded or guarded by location. Muller or mixer openings shall be guarded to prevent personnel from the foreseeable risk of accidental contact or hazardous approach to machine elements performing the mixing or mulling. Sand or additive entry points or discharge doors shall be guarded by a barrier, screen, cover, or other means. Elements protected by virtue of their remote or inaccessible locations shall be considered to be guarded.

NOTE 26—Unprotected opening(s) encourage personnel to reach into the path of moving machine elements to take sand samples rather than using the sand-sampling device. The intent of this section is to prevent any part of the body from coming into the path of, or between, two or more moving elements or between a moving and a fixed machine element during operation. Secondary protection is recommended by electrically interlocking inspection doors.

8.1.8 *Entry Into Mullers or Mixers*—Mullers and mixers are confined spaces and it is possible that they are also permit-required confined spaces. Entry procedures shall be in conformance with 29 CFR 1910.146 and hazardous energy control (6.5) procedures.

8.1.9 *Sand Sampling*—When equipment is in operation, sand samples shall be taken externally.

8.1.10 *Sand Contamination*—Means shall be provided to minimize contamination of sand by tramp metal or debris.

NOTE 27—It is possible to achieve this by magnetic separation (for ferro-magnetic materials) or screening, or both.

8.1.11 *Skip Hoists, Operating Controls*—When material transfer is manually controlled, the operating controls shall be located so that:

8.1.11.1 The operator is isolated from the transfer mechanism,

8.1.11.2 The operator is not in the path of discharged material,

8.1.11.3 The operator has access to operating controls, and

8.1.11.4 The operator has an unobstructed view of the transfer point(s).

8.1.12 *Skip Hoists, Guarding*—Guards, shields, or other devices shall be provided so that the operator or other personnel are isolated from the path of operation of the skip hoist bucket or contact with any of the moving parts. If, by virtue of its location, the drive mechanism is isolated from contact by the operator and others, with the exceptions of authorized maintenance personnel, then it shall be considered to be guarded.

8.1.13 *Skip Hoists, Employer Responsibility*—It shall be the responsibility of the employer to provide equipment that complies with mandatory safety standards for that given category of equipment in accordance with ASME B20.1.

8.1.14 *Hazardous Substances*—The handling and storage of hazardous substances and the issuance of protective clothing, eyeshields, and respirators shall be in conformance with existing standards, regulations, and written PPE hazard assessments.

NOTE 28—A variety of substances, with potential flammable, explosive, and toxic properties, are used in the preparation of molding sand and core sand. Detailed and individual safety requirements for these substances are

considered not to be within the scope of this practice.

8.1.15 *Permissible Exposure Limits (PELs)*—Equipment, operations, and processes producing concentration of any airborne contaminant in excess of current PELs at the operator's breathing zone shall be provided with feasible engineering controls, administrative controls, or personal protective equipment that will reduce the contaminant below the PEL.

NOTE 29—Other exposure limits such as recommended exposure limits from NIOSH, airborne exposure standards from ASTM, manufacturer recommendations, and threshold limit values from the American Conference of Governmental Industrial Hygienists are often informative.

8.1.16 *Exhaust Systems for Shell Sand Mixers*—Ventilation controls for shell sand mixers shall be provided which will maintain the atmosphere within the mixer less than 25 % of the lower explosive limit (LEL).

NOTE 30—Shell resins are available in solid form or suspended or dissolved in water or a solvent such as alcohol. The intent of this section is that ventilation not only is required to control any dust generated to a level not exceeding the proper PEL, but to ensure that additional ventilation is supplied when solvent evaporation might cause an explosion hazard. For additional information, refer to ANSI/ASSP Z9.2 and AFS Managing the Foundry Indoor Air Environment.

## 8.2 Core Making:

8.2.1 Because of the large number of binder chemicals available, the Material Safety Data Sheet for the material used shall be consulted for information on possible chemical contaminants in the work environment.

NOTE 31—It is not the intent of this section to restrict the materials used in the core-making operation.

8.2.2 *Core-Making Equipment*—Hazardous areas and zones on core-making equipment shall be guarded by one or more of the methods listed in 6.2 of this practice.

8.2.3 *Blow Plate and Corebox Seal*—The operator shall be protected from sand that escapes from joints or parting lines.

NOTE 32—Any one or more of the following means are acceptable ways to protect from sand:

(1) Not permitting magazine faces, blow plates, and mating surfaces on coreboxes to become worn to the point at which a good mechanical seal cannot be achieved.

(2) Cleaning loose sand from all mating surfaces before the corebox is blown.

(3) Use of sealing members between mating surfaces.

(4) Protective shields or curtains between the operator and machine.

(5) Good maintenance of vents and blow tubes or slots.

8.2.4 *Corebox Handles*—Core blower boxes shall be provided with means for positioning and removal of the box without any portion of the operator's hands exposed to pinch points. When safe gripping points are not naturally provided, they shall be added.

NOTE 33—Some coreboxes, by the nature of their height, size, and configuration, provide safe gripping points for the operator's hands.

8.2.5 *Corebox Pressure*—Coreboxes shall be capable of withstanding the pressure of forces, both mechanical and pneumatic, imposed.

NOTE 34—It is not the intent of this section to place a restriction either on the materials used for, or the method of, constructing a corebox. A well-constructed corebox for use with either a coreblower or coresooter allows for simultaneous introduction and exhaust of the air, leaving only