GUIDE FOR SELECTION & USE OF PERSONAL PROTECTIVE EQUIPMENT & SPECIAL CLOTHING FOR FOUNDRY OPERATIONS

AFS Safety and Health Committee (10Q)

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AMERICAN FOUNDRY SOCIETY

GUIDE FOR SELECTION AND USE OF PERSONAL PROTECTIVE EQUIPMENT AND SPECIAL CLOTHING FOR FOUNDRY OPERATIONS

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Outline

1. Scope

1.1 This Guide describes special considerations for selection and use of personal protective equipment (PPE) and special clothing for work situations that present a risk of exposure to foundry hazards.

1.2 This guide is intended to supplement an individual facility's Hazard Assessment for Personal Protective Equipment Selection.

1.3 This guide does not take the place of other standards and requirements such as OSHA regulations, ANSI standards, manufacturer recommendations as listed on material safety data sheets and product information, or other standards that relate to personal protective equipment.

1.4 This guide is not the absolute answer to PPE selection. Company personnel, with their intimate knowledge and familiarity with melting and pouring and other foundry processes are in the best position to determine what PPE is the most appropriate, practical, effective and useful for employee health and safety.

1.5 The American Foundry Society, Inc., or its participants are not responsible and can not be held liable for errors or omissions on behalf of this document. To the best of our knowledge, findings herein are true and accurate at the time of writing.

2. How to Use This Guide

2.1 Use this guide as a tool in ***completing the hazard assessment***. See Attachment 1 for a sample form.

2.2 Identify the potential hazards of the job being evaluated.

2.3 Locate the section for the operation and protection item or body part, (e.g. special clothing for melting and pouring (6.1) or eye protection for melting and pouring (6.2), etc.)

2.4 Basic protection is the minimum requirement that applies to everyone in the area—workers, supervisors, engineers, technicians, observers, etc.

2.5 Refer to the "Hazards", "Considerations for Hazard Assessment", and "Recommendations and Comments" sections for additional information.

3. Referenced Documents

3.1 ASTM Standards

- E 2349 Standard Practice for Safety in Metal Casting Operations: Sand Preparation, Molding, and Core Making; Melting and Pouring; and Cleaning Operations
- F 955 Standard Test Method for Evaluating Heat Transfer Through Materials for Protective Clothing Upon Contact with Molten Metal
- F 1002 Standard Performance Specification for Protective Clothing for Use By workers Exposed to Specific Molten Substances and Related Thermal Hazards
- F 1449 Standard Guide for Care and Maintenance of Flame Resistant and Thermally Protective Clothing
- F 2412 Test Methods for Foot Protection
- F 2413 Specification for Performance Requirements for Protective Footwear

3.2 ANSI Standards

- ANSI/ISEA 105 American National Standard for Hand Protection Selection Criteria
- ANSI Z87.1 American National Standard for Occupational and Educational Personal Eye and Face Protection Devices
- ANSI Z88.2 American National Standard for Respiratory Protection
- ANSI Z89.1 American National Standard for Industrial Head Protection

3.3 OSHA Standard

29 CFR 1910 Subpart I - Personal Protective Equipment

4. Terminology and Abbreviations

Chaps –long leggings worn over pants from the waist to the ankle, often open in the back

Clothing – As used in this guide refers to garments customarily worn in both work and non-work environments. May include shirts, pants, undergarments and shoes (see also special clothing).

Ferrous - Metals that consist primarily of iron.

FR cotton (Flame resistant cotton) - cotton fabric that has been treated to self-extinguish upon the removal of an ignition source.

Hazardous Zone – that area where the potential for bodily injuries exists

Leggings - a garment covering the lower leg (usually extending from the knee to the ankle)

Non-ferrous – Aluminum - any metal or metal alloy whose principal constituent is aluminum (Al).

Non-ferrous – Copper based - any metal or metal alloy whose principal constituent is Copper (Cu). Includes brass and bronze. Alloys often contain lesser amounts of zinc, lead, tin or other metals.

Non-ferrous – Magnesium - any metal or metal alloy whose principal constituent is magnesium (Mg).
Non-ferrous – Other special metals – includes zinc (Zn), gold (Au) and silver (Ag).
Personal Protective Equipment (PPE) – includes a variety of devices and garments to worn by workers to protect themselves from hazards.
Spats – a covering for the top and sides of the boot (metatarsal, instep, and ankle area)
Special Clothing – garments with specific designs, fabrics, or treatments with protective characteristics. For example, FR fabrics, safety shoes, pants without cuffs, or even 100% cotton clothing when required for a specific application.

Abbreviations:

- ANSI = American National Standards Institute
- ASTM = American Society for Testing and Materials
- CFR = Code of Federal Regulations
- FR = Flame Resistant
- HA = Hazard Assessment (refer to OSHA 29 CFR 1910.132)
- OSHA = Occupational Safety and Health Administration
- PEL = Permissible Exposure Limit
- PPE = Personal Protective Equipment

5. General Considerations for Selection and Use of PPE and Special Clothing

5.1. In safety and health practice the hierarchy of controls specifies elimination of the hazard as the primary strategy for exposure reduction, followed by engineering controls, work practices, and administrative controls. Personal protective equipment is regarded as a last resort due to issues associated with comfort, fit, acceptability and reliability.

5.2. PPE requirements shall be based on a hazard assessment as required by OSHA standard 29CFR 1910.132. Each job and related work activity shall be evaluated. The hazard assessment shall be reviewed when job hazards change and shall be modified as necessary. The hazard assessment should be reviewed annually. The hazard assessment shall be documented and reviewed with employees.

5.3. Employees who are required to wear PPE or special clothing shall be trained in its limitations, proper inspection, use, care, and storage. An employee must be retrained when:

- work habits or demonstrated knowledge indicates a lack of the necessary understanding, motivation, and skills required to use the PPE (i.e., uses PPE improperly),
- changes in the workplace make previous training out-of-date (i.e., when employees change jobs or new equipment is introduced), or
- changes in the types of PPE to be used make previous training out-of-date.

5.4. PPE must be properly worn, maintained, cleaned and disposed of. In situations where contaminated clothing or equipment may pose a risk to persons other than the user (for example, laundry workers) those individuals shall be provided with appropriate hazard warning information.

5.5. It is recommended that wearing jewelry, including exposed body piercing jewelry, be prohibited in all foundry departments.

5.6. Protective clothing may add to the heat load of the worker. Recognize the potential for heat stress when selecting special clothing. A heat stress program may be necessary to manage the potential heat stress hazard.

6. Clothing and PPE for Melting and Pouring Operations

6.1. Clothing and PPE for Melting and Pouring Operations - Ferrous and Non-Ferrous Metals

Basic Protection:
Recommended minimum special clothing for all melting and pouring operations For employees in a hazardous zone (such as near a furnace or ladle containing molten metal or other known hazards) additional application specific clothing and PPE is required.

The following are basic protection:

- 100% cotton socks and undergarments
- 100% cotton or wool outer garments

Potential Hazards: Evaluate the applicability of these items when performing the hazard assessment.	**Application Specific Protection:** Based on the results of the hazard assessment some operations may require additional clothing and PPE beyond the basic protection. (See following sections for additional PPE requirements for eye and face; head, hand and foot; hearing; and respiratory protection.)
Hazards: • Burns from physical contact with molten metal splash, molten metal run-out, spills, sparks, flames, hot surfaces, cold tools or liquid introduction into molten metal (explosion). • Burns and heat stress from exposure to radiant heat. • Magnesium only - Spontaneous ignition of dust • Airborne contaminants such as dust and fumes	**Materials:** • Aluminized Kevlar* • Aluminized cotton • Leather • Iron and Steel only - FR cotton • Wool • Aluminized leather • Aluminized wool • Other fabrics (such as Vinex*, PR-97*, Oasis*) which are acceptable as determined by ASTM F1002 **Types of PPE:** • Coats • Jackets • Aprons • Cape, sleeve(s) and bib • Leggings • Chaps • Spats

Considerations for Hazard Assessment:

- Presence of molten metal in furnace, ladle and/or mold.
- Temperature of the metal or hot surface.
- The level of the metal and area of the body that could be impacted by a splash, runout, sparks, flames, or hot surfaces.
- Proximity to molten metal and hot surfaces (for example, work inside hazard zone around induction furnaces).
- Material being handled (e.g. additives, chilling blocks)
- Amount of metal will affect the amount of radiant heat and quantity of metal, melted or poured, that could impact the body.

Recommendations and Comments:

1. Reference 29 CFR 1910.132 for OSHA General PPE requirements.
2. Refer to ASTM F 1002 and request to see the results of the ASTM F 955 test for specific fabrics.
3. ASTM F 955 tests are conducted using pure metals and results may be different with various alloys. Users should conduct tests with their own alloys to compare fabric performance.
4. Wear pants or leggings that cover the top of the boot to prevent molten metal and sparks from entering the boot. Never tuck pant legs inside the boot.
5. If laced boots are worn, spats or leggings that cover the lacings must be used whenever molten metal or sparks could lodge in the tongue area.
6. Do **not** wear Nomex* because all molten metals tend to stick to the fabric.
7. **Non-Ferrous Metals** – Do **not** wear phosphorus treated cotton because molten metal tends to stick to the fabric. Nearly all FR cotton fabrics use phosphorous based treatment.
8. Do **not** wear polyester, nylon, and other manmade materials that can melt and readily ignite.
9. Long pants are required and long sleeve shirts are recommended.
10. For pouring operations the use of spats, leggings, and chaps should be evaluated.
11. Wear clothing that does not trap molten metal and sparks (i.e. no cuffs, open pockets, loose legging tops, etc.).
12. Maintain all protective clothing in serviceable condition. No holes, rips, tears or repaired fabrics. Flame retardant properties must be maintained. Refer to ASTM F 1449.
13. Wear types of PPE in any combination as needed to protect body parts that are exposed to heat or metal splatter as determined by the hazard assessment (HA) for each work activity.
14. Protective clothing may add to the heat load of the worker. Recognize the potential for heat stress when selecting special clothing. A heat stress program may be necessary to manage the potential heat stress.
15. Aluminized PPE is appropriate for high heat and spark producing areas such as lancing or tapping out cupolas, or where molten metal splash from a furnace is possible. It is not universally required when pouring metal into molds.
16. Plastic cigarette lighters shall be prohibited from melting and pouring areas.

6.2 Eye and Face Protection for Melting and Pouring Operations

Basic Protection:
Recommended minimum special clothing for all melting and pouring operations for employees in a hazardous zone (such as near a furnace or ladle containing molten metal or other known hazards) additional application specific clothing and PPE is required.

The following is basic protection:

- Safety Glasses with side protection.

Potential Hazards: Evaluate the applicability of these items when performing the hazard assessment.	**Application Specific Protection:** Based on the results of the hazard assessment some operations may require additional PPE beyond the basic protection.
Hazards: • Eye and face injuries from foreign bodies, molten metal splash, chemicals • Damage from infrared and/or ultraviolet radiation.	• Goggles • Face shield • Full face shield, materials: acrylic or #40 steel wire mesh • Tinted glasses: Iron- Shade #3-#5 Green Steel- Shade #8 Green or Shade #6 Cobalt Blue Brass Shade #3-#5 Green or Shade #3 Green with #3 Aluminized Face Shield or Shade #6 Cobalt Blue (half-lenses) Aluminum Clear, No-Tint Magnesium Clear, No-Tint

Considerations for Hazard Assessment:

- High temperature surfaces emit infrared radiation
- Electric arcs emit ultraviolet radiation.

Recommendations and Comments:

1. Reference OSHA standard 29 CFR 1910.133.
2. Refer to ANSI Z87.1 for eye protection specifications.
3. Use the appropriate darker glasses for intense radiant energy.
4. Eye protection that is too dark may reduce visibility and create hazards such as tripping. Switch to lower shade numbers during extended periods when no molten metal viewing is required.
5. Higher shade numbers are for direct viewing of molten metal for extended periods of time such as for making quality checks, pouring, or slagging.
6. Lower shade numbers can be used where molten metal viewing is momentary or incidental.
7. Ultravioler (UV) and Infrared (IR) radiation exposure follows the inverse square law; therefore, the exposure level rapidly diminishes at greater distances.
8. A full face shield must be worn where workers are exposed to a potential hazard of molten metal splash.
9. When face protection is worn, safety glasses with side protection must also be worn.

6.3 Head, Hand, and Foot Protection for Melting and Pouring Operations

Basic Protection:
Recommended minimum special clothing for all melting and pouring operations for employees in a hazardous zone (such as near a furnace or ladle containing molten metal or other known hazards) additional application specific clothing and PPE is required.

The following is basic protection:

- Leather safety shoe with toe protection and smooth toe.

Potential Hazards: Evaluate the applicability of these items when performing the hazard assessment.	**Application Specific Protection:** Based on the results of the hazard assessment some operations may require additional PPE beyond the basic protection.
Hazards: • Head injuries from falling objects, moving equipment and/or overhead obstructions. • Burns from physical contact with molten metal splash, sparks, flames and/or hot surfaces. • Foot injuries from falling or rolling objects, • Scrapes, cuts, and abrasions	• **Head Protection** o Hard hat o Cotton cap o Wool cap o Aluminized Hood • **Hand Protection** Materials: o Leather o Cotton o Wool o Kevlar o Wool lined Kevlar o Aluminized fabrics o Other heat resistant materials Types of PPE: o Mitts o Cover mitts o Cover pads o Gloves • **Foot Protection** o Metatarsal safety shoe o Heat resistant soles

Recommendations and Comments:

Head Protection

1. Reference OSHA standard 29 CFR 1910.135.
2. Refer to ANSI Z89.1 for hard hat specifications.
3. Cotton or wool caps may provide protection where minor metal splatter may contact head.

Hand Protection

1. Reference OSHA standard 29 CFR 1910.138.
2. Consider need for dexterity and grip security when operating equipment.
3. Consider the gauntlet type glove, if there is no chance of metal being spilled into the glove.
4. Do **not** wear Nomex* gloves as molten metal tends to stick to the fabric.

Foot Protection

1. Reference OSHA standard 29 CFR 1910.136.
2. Refer to ASTM F 2412 and F 2413 for foot protection specifications.
3. If metatarsals are worn select built in design or wear spats or leggings that cover areas where molten metal or sparks could lodge.
4. A 6" or 8" "engineer's boot" is recommended.
5. If lace boots are worn, wear spats or leggings that cover the lacings whenever molten metal or sparks could lodge in the tongue area.
6. Wear pants or leggings that cover the top of the boot to prevent molten metal and sparks from entering the boot. Never tuck pant legs inside the boot or spat.
7. Do **not** use shoes with exposed zippers or elastic materials that could melt or ignite.

6.4 Hearing Protection for Melting and Pouring Operations

Basic Protection:
Recommended minimum protection for all melting and pouring operations for employees in a hazardous zone application specific protection is required.

Hearing protection may not be necessary depending on noise level, frequency and duration of exposure.

Potential Hazards: Evaluate the applicability of these items when performing the hazard assessment.	**Application Specific Protection:** Based on the results of the hazard assessment, including noise level monitoring results, some operations may require hearing protection.
Hazards: • Hearing loss due to noise exposure	**Materials:** • Ear plugs • Ear muffs • Ear caps

Considerations for Hazard Assessment:
- Results of noise level monitoring

Recommendations and Comments:
1. Reference OSHA standard 29 CFR 1910.95.
2. Avoid use of hearing protection that may be combustible, such as some urethane foam earplugs.
3. Select hearing protection that provides sufficient noise reduction for the exposure.

6.5 Respiratory Protection for Melting and Pouring Operations

Basic Protection:
Recommended minimum protection for all melting and pouring operations for employees in a hazardous zone application specific protection is required.

Respiratory protection may not be necessary depending on level, frequency and duration of exposure.

Potential Hazards: Evaluate the applicability of these items when performing the hazard assessment.	**Application Specific Protection:** Based on the results of the hazard assessment, including industrial hygiene monitoring results, some operations may require specific respiratory protection.
Hazards: • Exposure to toxic metals (lead, cadmium, arsenic, beryllium, etc) either as part of the alloy or as a contaminant of the scrap being melted • Exposure to toxic gases (for example - chlorine or fluorides used for degassing aluminum) • Crystalline silica exposures from other foundry areas • **Magnesium only** – Acid gases when sludging	Respiratory protection (particulate, metal fumes, organic vapor, acid gas, etc.) • Half mask respirator • Full facepiece respirator • Filtering facepiece respirator (Air-purifying respirator) • Powered air-purifying respirator (PAPR)

Considerations for Hazard Assessment:
- Results of industrial hygiene monitoring of dusts, metal fumes, gases and vapors

Recommendations and Comments:
1. Reference OSHA standard 29 CFR 1910.134 and substance specific standards (e.g., OSHA standard 29 CFR 1910.1025 for lead).
2. Refer to NIOSH certification 42 CFR 84 for respirator selection.
3. Respirator selection must be appropriate for the type of contaminant, and for concentration and duration of exposure.
4. Where respirators are required employees must be medically evaluated and approved, fit-tested, and trained prior to respirator use.
5. A respirator approved for protection against acid gas exposure should be worn when sludging a magnesium crucible. Both particulate and acid gases are a result of the fluxing operation.
6. Facial hair must not interfere with respirator seal.

7.0 Clothing and PPE for Molding and Core Making Operations

Basic Protection:
Recommended minimum protection for all molding and core making operations: For employees in a hazardous zone application specific protection is required.

The following are basic protection:

- Clothing - 100% cotton shirt and long pants
- Eye Protection - Safety glasses with side shields
- Foot Protection - Safety toe footwear

Potential Hazards: Evaluate the applicability of these items when performing the hazard assessment.	**Application Specific Protection:** Based on the results of the hazard assessment some operations may require additional clothing and PPE beyond the basic protection.
Hazards: • Heat and hot surfaces • Rolling and pinching exposures (cores, coreboxes, lifting devices) • Sharp objects and edges • Flying and falling objects (sand, cores, plywood separators) • Dust from core making and cleaning • Chemical splash and spray (resins, catalysts, parting sprays) • Acids and caustics from scrubbers • Noise • Airborne contaminants (Silica, formaldehyde, ammonia, amines, CO_2, SO_2, phenol, isocyanates, etc.)	**Protective Clothing** • Long sleeve shirts • Iron and Steel only -FR cotton • Sleeves • Coveralls, apron **Hand protection** • Gloves (heat, chemical, cut resistant) • Anti-vibration gloves **Head protection** • Hard hat/bump cap **Foot protection** • Metatarsal safety shoes **Eye and Face protection** • Goggles (impact, chemical resistant) • Face shield **Hearing protection** • Ear plugs, caps and muffs **Respiratory protection** (particulate, metal fumes, organic vapor, etc.) • Half mask respirator • Full facepiece respirator • Filtering facepiece respirator • Air-purifying respirator (APR) • Powered air-purifying respirator (PAPR) • Air supplied hood

Considerations for Hazard Assessment:

- Results of industrial hygiene monitoring of noise, dusts, metal fumes, gases and vapors
- Materials used (refer to Material Safety Data Sheets for hazardous ingredients and recommended precautions)
- Arrangement of job (overhead work, machine guarding, size and weight of core)

Recommendations and Comments:

Protective Clothing

1. Reference 29 CFR 1910.132 for OSHA PPE requirements.
2. 100% cotton clothing should be worn when working around hot box or shell core machines

Hand Protection

1. Reference OSHA standard 29 CFR 1910.138.
2. Consider need for dexterity and grip security when operating equipment.
3. Select gloves that provide chemical resistance to materials in use.

Head Protection

1. Reference OSHA standard 29 CFR 1910.135.
2. Refer to ANSI Z89.1 for hard hat specifications

Foot Protection

1. Reference OSHA standard 29 CFR 1910.136.
2. Refer to ASTM F 2412 and F 2413 for foot protection specifications.

Eye and Face Protection

1. Reference OSHA standard 29 CFR 1910.133.
2. Refer to ANSI Z87.1 for eye protection specifications.

Hearing Protection

1. Reference OSHA standard 29 CFR 1910.95.
2. Select hearing protection that provides sufficient noise reduction for the exposure.

Respiratory Protection

1. Reference OSHA standard 29 CFR 1910.134.
2. Refer to NIOSH certification 42 CFR 84 for respirator selection.
3. Respirator selection must be appropriate for the type of contaminant, and for concentration and duration of exposure.
4. Where respirators are required employees must be medically evaluated and approved, fit-tested, and trained prior to respirator use.
5. An air-supplied hood may also provide protection from heat and eye hazards. See Section 11.

8.0 Clothing and PPE for Cleaning and Finishing

Basic Protection:
Recommended minimum protection for all cleaning and finishing operations: For employees in a hazardous zone application specific protection is required.

The following are basic protection:

- Clothing - 100% cotton shirt and long pants
- Eye Protection - Safety glasses with side protection
- Foot Protection - Safety toe footwear

Potential Hazards: Evaluate the applicability of these items when performing the hazard assessment.	**Application Specific Protection:** Based on the results of the hazard assessment some operations may require additional clothing and PPE beyond the basic protection.
Hazards: • Heat, sparks and hot surfaces • Rolling, pinching and abrasive exposures (castings, grinding equipment, hand tools, lifting devices) • Sharp objects and edges (gating and flashings) • Vibration (hand, swing and stand grinding and chipping) • Flying and falling objects (sand, castings, shattering grinding wheels) • Dust and particles from shakeout, shot blast, grinding and cleaning • Noise • Airborne contaminants (Silica, dust, metal particulate) • Hazards associated with welding, cutting, and scarfing	**Protective clothing** • Long sleeve shirts • Iron and Steel only - FR cotton • Sleeves • Coveralls, apron • Welding apparel **Hand protection** • Gloves (heat, cut resistant) • Anti-vibration gloves **Head protection** • Hard hat/bump cap **Foot protection** • metatarsal safety shoes **Eye and Face protection** • Dust sealed glasses/goggles • Goggles (impact resistant) • Face shield • Air supplied hood • Welding helmets **Hearing protection** • Ear plugs, caps and muffs **Respiratory protection** (particulate, metal fumes, etc.) • Half mask respirator • Full facepiece respirator • Filtering facepiece respirator • Air-purifying respirator (APR) • Powered air-purifying respirator (PAPR) • Air supplied hood

Considerations for Hazard Assessment:

- Results of industrial hygiene monitoring of noise, dusts, metal fumes, gases and vapors
- Size, weight and configuration of castings.
- Content of alloy

Recommendations and Comments:

Protective Clothing

1. Reference 29 CFR 1910.132 for OSHA PPE requirements.
2. 100% cotton clothing should be worn when working around hot castings.
3. Sleeves should protect against hot surfaces.

Hand Protection

1. Reference OSHA standard 29 CFR 1910.138.
2. Consider need for dexterity and grip security when operating equipment.
3. Hand protection may provide a combination of cut and vibration protection or may be layered.

Head Protection

1. Reference OSHA standard 29 CFR 1910.135.
2. Refer to ANSI Z89.1 for hard hat specifications

Foot Protection

1. Reference OSHA standard 29 CFR 1910.136.
2. Refer to ASTM F 2412 and F 2413 for foot protection specifications.

Eye and Face Protection

1. Reference OSHA standard 29 CFR 1910.133.
2. Refer to ANSI Z87.1 for eye protection specifications.
3. Refer to ANSI Z49.1 for welding protection.

Hearing Protection

1. Reference OSHA standard 29 CFR 1910.95.
2. Select hearing protection that provides sufficient noise reduction for the exposure.

Respiratory Protection

1. Reference OSHA standard 29 CFR 1910.134.
2. Refer to NIOSH certification 42 CFR 84 for respirator selection.
3. Respirator selection must be appropriate for the type of contaminant, and for concentration and duration of exposure.
4. Where respirators are required employees must be medically evaluated and approved, fit-tested, and trained prior to respirator use.
5. An air-supplied hood may also provide protection from heat and eye hazards. See Section 11.

9.0 Clothing and PPE for Machining

Basic Protection:
Recommended minimum protection for all machining operations: For employees in a hazardous zone application specific protection is required.

The following are basic protection:

- Clothing - Long pants
- Eye Protection - Safety glasses with side protection
- Foot Protection - Safety toe footwear

Potential Hazards: Evaluate the applicability of these items when performing the hazard assessment.	**Application Specific Protection:** Based on the results of the hazard assessment some operations may require additional clothing and PPE beyond the basic protection.
Hazards: • Rolling and pinching exposures (castings, rotating machinery, lifting devices) • Sharp objects and edges • Flying and falling objects • Dust and particles from machining • Chemical exposures (coolants and lubricants) • Noise • Airborne contaminants (metal particulates, metalworking fluids) • Burns from hot chips or parts	**Protective clothing** • Long sleeve shirts • Sleeves **Hand protection** • Gloves **Head protection** • Caps • Shrouds • Hair net **Foot protection** • Metatarsal safety shoes **Eye and Face protection** • Goggles (impact, chemical resistant) • Face shield **Hearing protection** • Ear plugs, caps and muffs **Respiratory protection** (particulate, metal fumes, organic vapor, etc.) • Half mask respirator • Full facepiece respirator • Filtering facepiece respirator • Air-purifying respirator (APR)

Considerations for Hazard Assessment:

- Results of industrial hygiene monitoring of noise, dusts, metal fumes, gases and vapors
- Size, weight and configuration of castings.

Recommendations and Comments:

Protective Clothing

1. Reference 29 CFR 1910.132 for OSHA PPE requirements.
2. Machine operators should never wear jewelry or loose fitting clothing, especially loose sleeves or jacket cuffs and neckties.

Hand Protection

1. Reference OSHA standard 29 CFR 1910.138.
2. Gloves may be worn as long as another hazard is not created. Gloves should not be worn on some machine operations (e.g., with exposed rotating tools or parts)
3. Where worn, gloves with a tight fitting knitted cuff may reduce the possibility of snagging on equipment and may help keep chips out.
4. Barrier creams and personal hygiene may reduce skin irritation.

Head Protection

1. Reference OSHA standard 29 CFR 1910.135.
2. Refer to ANSI Z89.1 for hard hat specifications
3. Keep long hair that could be caught by moving parts covered.
4. Caps and shrouds should not have dangling parts

Foot Protection

1. Reference OSHA standard 29 CFR 1910.136.
2. Refer to ASTM F 2412 and F 2413 for foot protection specifications.

Eye and Face Protection

1. Reference OSHA standard 29 CFR 1910.133.
2. Refer to ANSI Z87.1 for eye protection specifications.

Hearing Protection

1. Reference OSHA standard 29 CFR 1910.95.
2. Select hearing protection that provides sufficient noise reduction for the exposure.

Respiratory Protection

1. Reference OSHA standard 29 CFR 1910.134.
2. Refer to NIOSH certification 42 CFR 84 for respirator selection.
3. Respirator selection must be appropriate for the type of contaminant, and for concentration and duration of exposure.
4. Where respirators are required employees must be medically evaluated and approved, fit-tested, and trained prior to respirator use.
5. An air-supplied hood may also provide protection from heat and eye hazards. See Section 11.

10.0 Clothing and PPE for Maintenance and Other Foundry Operations

Basic Protection:
Recommended minimum protection for all maintenance operations: For employees in a hazardous zone application specific protection is required.

The following are basic protection:

- Clothing - 100% cotton shirt and long pants
- Eye Protection - Safety glasses with side shields
- Foot Protection - Safety toe footwear

Potential Hazards: Evaluate the applicability of these items when performing the hazard assessment.	**Application Specific Protection:** Based on the results of the hazard assessment some operations may require additional clothing and PPE beyond the basic protection. Refer to specific process requirements listed in previous sections for appropriate clothing and PPE when performing tasks in those areas. For example when working in the melting and pouring area refer to Sections 6.1 through 6.5.
Hazards: • Heat and hot surfaces • Rolling and pinching exposures • Sharp objects and edges • Flying and falling objects • Electrical hazards • Slips, trips and falls • Dust and particles from core making and cleaning • Compressed air • Confined spaces • Mechanical, manual handling • Chemical splash and spray (resins, catalysts, parting sprays) • Acids and caustics from scrubbers • Noise and vibration • Airborne contaminants (Silica, formaldehyde, ammonia, amines, CO_2, SO_2, phenol, isocyanates, welding fume, etc.)	**Protective clothing** • Long sleeve shirts • Iron and Steel only - FR cotton • Sleeves • Coveralls, apron • Clothing suitable for arc flash protection **Hand protection** • Gloves (heat, chemical, cut resistant) • Anti-vibration gloves • Electrically insulated gloves **Head protection** • Hard hat/bump cap **Foot protection** • Metatarsal safety shoes • Non-conductive shoes **Fall Protection** • Safety harness **Eye and Face protection** • Goggles (impact, chemical resistant) • Face shield • Welding helmet **Hearing protection** • Ear plugs, caps and muffs **Respiratory protection** (particulate, metal fumes, organic vapor, etc.) • Half mask respirator • Full facepiece respirator • Filtering facepiece respirator • Air-purifying respirator (APR) • Powered air-purifying respirator (PAPR)

Considerations for Hazard Assessment:

- Refer to previous sections for hazards associated with work in those areas.
- Results of industrial hygiene monitoring of noise, dusts, metal fumes, gases and vapors.

Recommendations and Comments:

Protective Clothing

1. Reference 29 CFR 1910.132 for OSHA PPE requirements.
2. Maintenance personnel perform a wide variety of tasks in different areas of the foundry. Appropriate clothing and PPE must be available for performing work in these different areas, especially when performing non-routine tasks. PPE must be appropriate both for the task being performed and the area where it is being done.

Hand Protection

1. Reference OSHA standard 29 CFR 1910.138.
2. Gloves may be worn as long as another hazard is not created. Gloves should not be worn on some machine operations (e.g., with exposed rotating tools or parts)
3. Where worn, gloves with a tight fitting knitted cuff may reduce the possibility of snagging on equipment and may help keep chips out.
4. Barrier creams and personal hygiene may reduce skin irritation.

Head Protection

1. Reference OSHA standard 29 CFR 1910.135.
2. Refer to ANSI Z89.1 for hard hat specifications
3. Keep long hair that could be caught by moving parts covered.
4. Caps and shrouds should not have dangling parts

Foot Protection

1. Reference OSHA standard 29 CFR 1910.136.
2. Refer to ASTM F 2412 and F 2413 for foot protection specifications.

Eye and Face Protection

1. Reference OSHA standard 29 CFR 1910.133.
2. Refer to ANSI Z87.1 for eye protection specifications.

Hearing Protection

1. Reference OSHA standard 29 CFR 1910.95.
2. Select hearing protection that provides sufficient noise reduction for the exposure.

Respiratory Protection

1. Reference OSHA standard 29 CFR 1910.134.
2. Refer to NIOSH certification 42 CFR 84 for respirator selection.
3. Respirator selection must be appropriate for the type of contaminant, and for concentration and duration of exposure.
4. Where respirators are required employees must be medically evaluated and approved, fit-tested, and trained prior to respirator use.
5. An air-supplied hood may also provide protection from heat and eye hazards. See Section 11.

11.0 Use of Air Supplied Hoods and Powered Air Purifying Respirators (PAPR)

In choosing strategies for protecting employees from exposures to airborne contaminants and other hazards the hierarchy of control can be used. Elimination or substitution is the first level of control in the hierarchy. Engineering control, including ventilation, is next. Then comes administrative controls, followed by personal protective equipment. When it comes to choosing respiratory protection in foundries there is a need to consider the advantages of air supplied helmets or hoods.

Air supplied hoods are treated as respirators because they do provide respiratory protection; however, they lack many of the deficiencies of other respirators. Moreover, air supplied hoods can be used for more than just respiratory protection, such as for cooling and for eye and face protection from grinding particles.

Rationale for Hierarchy of Controls

In safety and health practice the hierarchy of controls specifies elimination of the hazard as the primary strategy for exposure reduction, followed by engineering controls, and work practice and administrative controls. In the case of most forms of personal respiratory protection, the following issues place negative pressure respirators at the bottom of the hierarchy:

- Poor fit can cause leakage and compromise protection.
- Respirators can be hot, uncomfortable to wear, and irritating to the skin.
- Respirators are incompatible with beards and mustaches.
- Facial deformities (e.g. lack of dentures) can cause poor seals.
- Poor maintenance of seals, valves, etc can cause reliability problems.
- Storage practices may lead to contamination.
- It is not practical to measure exposure inside the respirator so a protection factor must be relied upon.

These issues apply to negative pressure respirators, but they are less valid arguments for air supplied hoods. Poor fit and leakage problems with air supplied hoods are minimal except for gross and easily monitored abuses such as removal of the face piece or shroud. Air supplied hoods are comfortable; indeed, they are often requested where not required. Facial hair and facial deformities have no impact on effectiveness. Maintenance, reliability, and contamination are less of a problem with air supplied hoods than with most negative pressure respirators. . Finally, it is possible to measure exposures inside the hood to determine the actual protection achieved.

Effectiveness and Reliability

Air supplied hoods are effective and reliable. When ventilation systems are used to control exposures, the ventilation is usually designed to control exposures to the PEL or below. This approach is not always effective in achieving a reduction to below the PEL. Even when ventilation successfully reduces exposures to below the PEL, the control may be inconsistent. Air supplied hoods can achieve exposure levels 2 or 3 orders of magnitude lower than the PEL. Air supplied hoods may thus provide more effective and consistent protection than negative pressure respirators, and in some cases can achieve lower exposure levels than ventilation systems.

Exhaust ventilation systems require maintenance and work procedures to control exposures properly. Ventilation performance problems can often occur without detection. In some cases work procedures or job parameters may disrupt the efficiency of ventilation systems. For example, a work piece may be too large for a booth or heat loads may require fans for cooling that disrupt air movement needed for contaminant capture. Air supplied hoods do not suffer from these problems with engineering control performance. Failure of the air supply is readily detected in air supplied hoods and job activities or heat loading do not impact the efficiency of the hoods. In fact, air supplied systems with a vortex component can provide heating and cooling for personal comfort.

Multipurpose Application

Air supplied hoods are useful for a variety of purposes, not merely for reducing respiratory exposures. Eye protection and heat protection are two notable functions of air supplied hoods. In dusty environments like foundries it is important to minimize dust particles on the face and in the hair because these secondary sources may get rubbed into the eye. Because they keep the whole head clean, air supplied hoods are much more effective in preventing eye injuries than goggles or face shields. Some employers use air supplied hoods mainly for the eye protection benefits.

Vortex controls allow practical personal heat and cooling control for the wearer for all season comfort. Employees often choose to wear air supplied hoods for comfort reasons when not required to do so for dust exposure protection.

Disadvantages of Air Supplied Hoods

Air supplied hoods suffer from several disadvantages:

- The air must be supplied through a hose that limits mobility of the user, so the hood is only practical where the job is relatively stationary and the hose can be protected from damage. Hoses must be arranged to minimize tripping hazards.
- Human factor issues related to the weight of the helmet, vision limitations, and claustrophobic responses on the part of a few employees.
- Requirements for a safe and reliable air supply. A breathing air compressor is required or a filter panel is needed to purify plant air to a grade D breathable quality. In addition, if an oil lubricated compressor is used a high temperature or carbon monoxide alarm is needed to ensure that breathing air is acceptable. If only a high temperature alarm is used, carbon monoxide must be monitored periodically.
- Air supplied hoods require continuous maintenance and frequent parts replacement.

Powered Air Purifying Respirators (PAPR)
Powered Air Purifying Respirators (PAPR) provide most of the same advantages as air supplied hoods but do not have a vortex component for temperature control. PAPRs are also limited in use by the availability of appropriate filter media for some specific contaminants. In general, PAPR units require more maintenance due to battery life and component reliability issues. However, PAPR units have an additional advantage of mobility that can be extremely valuable for many operations including maintenance and non-routine tasks. Engineering controls are not possible for many maintenance, repair or clean up operations that require mobility or that are not performed repeatedly in a fixed location.

Conclusion
Air supplied hoods and powered air purifying respirators should be considered as important options when choosing respiratory and other personal protection for employees.

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Appendix 1: Sample Hazard Assessment Form

The PPE Hazard Assessment form should be evaluated by someone who is competent in recognizing the hazards of each individual job classification.

PPE Hazard Assessment

Department_____
Job/Task_____ Date:_____

	General Body Parts Affected							
Hazards Present	**Trunk**	**Arm/ Hand**	**Head**	**Leg/ foot**	**Eyes**	**Ear**	**Respiratory**	Potential Hazard sources
Impact								
Penetration								
Foreign Bodies								
Pinch/Caught								
Falling, rolling objects								
Sharp objects								
Heat/Hot Surfaces								
Molten Metal								
UV/IR radiation								
Chemicals								
Dust/Fume								
Noise								
Electrical hazards								
Other								

SPECIFIC PERSONAL PROTECTIVE EQUIPMENT NECESSARY

	Check if Applicable	Specification
TRUNK		
Coats		
Jackets		
Apron		
Cape/Sleeve/ Bib		
Coveralls		
ARM/HAND		
Long sleeve		
Mitts		
Cover mitts		
Cover Pads		
Gloves		

	Check if Applicable	Specification
HEAD		
Hard hat		
Cotton cap		
Wool cap		
Aluminized hood		
Shroud		
Hair net		
LEG/FOOT		
Legging		
Chaps		
Spats		
Leather safety toe shoe		
Metatarsal		
Other		
EYE/FACE		
Safety glasses with side protection		
Goggles		
Face shield		
Full face shield		
Tinted glasses		
HEARING		
Ear plugs		
Ear muffs		
Ear caps		
RESPIRATORY		
Dust mask		
Half mask		
Full facepiece		
Powered air purifying		
Supplied air		
SCBA		
FALL PROTECTION		

Evaluated by:_____ Date:_____

Certified by:_____ Date:_____