OREGON OCCUPATIONAL SAFETY AND HEALTH DIVISION
DEPARTMENT OF CONSUMER AND BUSINESS SERVICES

PROGRAM DIRECTIVE

Program Directive: **A-113**
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SUBJECT: PPE: Foundries

AFFECTED CODES/ DIRECTIVES: Division 2/I, OAR 437-002-0134 Personal Protective Equipment,

PURPOSE: Provide guidelines for the interpretation, application and compliance evaluation of Division 2/I, OAR 437-002-0134 Personal Protective Equipment.

BACKGROUND: Conditions encountered within foundry operations preclude the establishment of rules which are all inclusive or which can be equally applied to all circumstances as they relate to the requirements for high-temperature protective equipment.

Radiant heat is unaffected by air circulation from fans, blowers, exhausts or other mechanical devices, thus the only protection against radiant heat is the reflective clothing or protective equipment used.

The frequency of heat stroke and heat stress in a particular individual is directly related to the degree of radiant heat in the foundry operation. To apply just one rule for all conditions and circumstances in a foundry, can create hazardous situations or injuries which might not have occurred had the rules been interpreted and applied in a more flexible manner based on the employer's knowledge of their individual operations. Unnecessary protective clothing may subject employees to possible injury or illness from the additional temperature rise created by the clothing and convective heat.

Conversely, the lack of protective clothing for radiant heat can result in severe heat stress and heat stroke accidents which can occur before the employees are aware of the problem.

ACTION:

A. The types of protective equipment needed and used in foundry operations and processes are determined, to a large extent, by the **variables** listed below.

1. Foundry Operations:

   a. Type of metal being processed.

   b. Processing method being used.

   c. Melting point of the metal being processed.

   d. Type of foundry.

   e. Rate of production.

   f. Size of the units being cast.

   g. Age, size and design of the plant.

   h. Location of the plant (i.e., north-south).

   i. Climatic conditions (hot-cold).

2. Pouring Process

   a. Radiant Heat - large pours can be expected to produce a higher degree of both radiant and convective heat than small pours.

   b. Elapsed Time - large pours require longer elapsed working time than smaller pours.

   c. Proximity - the closer to the pour, the higher the heat.

   d. Elevation - chest and face-high pours are more hazardous than knee-high pours.

   e. Size of Molds - a wide shallow mold will produce more heat than a narrow deep mold.

   f. Quantity of Molten Metal - large pours present more hazards in cases of splash or spill than small pours.

g. Specific Characteristics of Metals

- Some metals such as magnesium and aluminum will stick to clothing and tend to "pop" or blow and shower sparks over large areas, while other metals are relatively stable.
- Some metals react when a spill or splash occurs.
- Metals such as steel or iron tend to roll off common clothing and will not stick or adhere to the smooth cloth surface.
- Bronze does not stick to clean clothing while it does adhere to dirty or dusty clothing.
- Other metals have certain characteristics which are individually associated with that specific metal while in the molten stages.

B. Compliance officers must use the following information to determine compliance with OAR 437-002-0134

1. Foot Protection/Leggings:

a. "Leggings or high boots of leather, rubber, or other suitable material" means that each article of footwear, constructed of specific materials, must only be used in the processes or conditions for which they are designed. Such processes or conditions as those encountered in foundries or other molten metal work would require the wearing of boots, shoes, or leggings of leather, asbestos, or aluminized materials when working in molten metal, cutting, burning, or welding of metal, hot sand work, or any other areas where heat or heat associated conditions create a hazardous situation.

The appropriate leggings or high boots must be worn at all times by all employees engaged in molten metal pouring operations where the pouring level is higher than approximately ankle high of the worker engaged in the pouring operations.

b. Leggings, high boots, shoes, or any combination thereof worn in foundry molten metal operations, must have a smooth surface, with tight tops, or covered tops, which effectively repel hazardous materials such as molten metal or sparks. They must also prevent any entry of such materials into the tops of the footwear, or from becoming lodged in or on the footwear as in the leggings, straps or buckles, etc.

When leggings are worn in combination with any boots or shoes having any surface irregularities such as lacings, buckles, straps, etc., the leggings must be designed to totally enclose the irregularities or additional guards such as spats or metatarsal guards.

In foundry areas where "heat" is not a factor, conventional leather footwear may be worn except in areas where heavy objects are being moved or handled which could cause foot injuries. In this case boots or shoes of leather with steel safety toes must be worn.

c. "Special" types of shoes or footguards as addressed in the rule, could include but are not limited to footwear such as the so called "moulders boot," aluminized boots and shoes, and asbestos boots and shoes.

d. Defective" footwear includes but is not limited to footwear which is excessively worn, damaged, torn, or has other defects which negate the safety features of the footwear. This includes footwear which might be "effective" if it were not damaged. Defective footwear must not be worn in any working area in foundry operations.

"Ineffective" footwear is interpreted to mean footwear of any type or design which would not effectively repel hazardous materials such as molten metal, sparks, hot sand or flames, and/or would prevent their entry into the footwear by any means.

“Ineffective" footwear, depending on the conditions under which they are used, include but are not limited to cowboy type boots, engineers boots with loose open tops, tennis shoes, moccasins, shoes or boots with open

type lacing, buckles, or straps not covered with legging or spats, rubber boots or shoes, plastic boots or shoes, or other types of footwear not specifically designed for use in foundry operations or processes.

2. Clothing

a. Protective clothing used where radiant heat is a factor must be highly reflective such as aluminized cloth. Clothing used where "convective" heat or hot air is a factor can be cotton or wool or absorptive type cloth. See Table in **Appendix A** to aid in the selection of fabrics used in protective clothing

b. All clothing worn in foundry operations must be cotton, wool, aluminized cloth or asbestos type cloth.

c. All clothing worn in foundry operations must present a smooth surface facing the pouring operations, i.e., all pockets on shirts or jackets must have "flap" covering on the open tops.

d. All clothing must be in good repair with no rips, tear or other openings in the cloth.

e. Shirts must have long sleeves. Polyester or other synthetic material is not permitted.

f. Pants must not have "cuffs" or "front pockets" and the legs must extend below the ankle area of the foot unless spats or leggings are worn.

g. When existing conditions require the wearing of aluminized or asbestos clothing, then either aluminized legging or spats must be required.

h. When existing conditions require the wearing of aluminized or asbestos clothing, i.e., (pants, jackets and legging or spats) then approved face shields will be considered to be protective clothing and must be required and worn in all pouring operations.

EFFECTIVE DATE: This directive is effective immediately and will remain in effect until cancelled or superseded.

Appendix A

Use of the following table will aid in the selection of fabrics used in protective clothing. Numbers in the table represent a degree of protection based on the molten metal splash test as follows:

1 = No damage to skin
2 = <1 cm^2 area of skin showing 1° burn
3 = >1 cm^2 area showing 1° burn
4 = <1 cm^2 area showing 2° burn
5 = >1 cm^2 area showing 2° burn
6 = <1 cm^2 area showing SEVERE DAMAGE; possible 3° burn
7 = >1 cm^2 area showing SEVERE DAMAGE; possible 3° burns

Table

Fabric		Fabric Wt. in g/m^2	Flammability (Brit. Std. 3120)	Thermal Protective Index (Radiation) (Brit. Std. 3791)	Grade for Molten Metal Splash Test (Direct Pour for Iron Slag)								
					Iron 1540° C		Aluminum 680° C		Magnesium 710° C		Low Carbon Steel	Iron Slag (Splash)	Iron Slag Direct Pour
					1 kg	3 kg	0.64 kg	2 kg	0.4 kg	1.4 kg	1 kg 1650° C	1 kg	
1	Wool Melton	680	Pass	32	1	1	1	1	1	1	1	1	1
2	Wool Melton	530	Fail	22	1	6	1	1	1	2	2	3	2
3	Wool Melton – Zirpro Treated	400	Pass	17	2	7	1	6	2	3	3	-	-
4	Wool/Modacrylic	400	Fail	14	4	7	4	7	4	6	5	-	-
5	Asbestos	1000	Pass	20	-	7	-	7	-	7	-	-	-
6	Novaloid	365	Pass	15	6	7	3	7	6	7	-	-	-
7	Aramid	305	Pass	10	7	7	7	7	7	7	-	-	-
8	Modacrylic/ glass-coated	360	Pass	13	6	7	4	7	5	6	-	-	-
9	Wool worsted- Zirpro Treated	345	Pass	14	3	7	1	6	1	6	3	-	-
10	Wool worsted- Zirpro Treated	270	Pass	9	6	7	2	7	4	7	-	-	-
11	Cotton – Proban Treated	340	Pass	16	3	7	6	7	5	7	3	-	-
12	Cotton – Pyrovatex Treated	275	Pass	7	6	7	7	7	7	7	-	-	-
13	Wool pile (knitted)	1000	Pass	36	1	1	1	1	1	1	-	-	-
14	Wool/PVC/Glass	445	Pass	14	6	7	6	7	6	7	-	-	-
15	Wool/Nylon	640	Fail	18	3	7	1	4	1	4	3	3	2
16	Wool – Neoprene Coated	909	Pass	36	-	2	-	1	-	1	-	-	-
17	Wool – Aluminized	780	Pass	142	-	4	-	6	-	6	-	-	-
18	Cotton – Aluminized	424	Pass	97	-	7	-	7	-	7	-	-	-
19	Asbestos – Aluminized	1200	Pass	128	-	7	-	7	-	7	-	-	-

NOTE: Table from Mehta, PN and K Willerton "Evaluation of clothing materials for protection against molten metals" Textile Institute and Industry, October 1977.