FOOT PROTECTION ON THE JOB
ENSURE COMPLIANCE WITH UPDATED SAFETY FOOTWEAR STANDARDS

Technical Guide

Honeywell

INTRODUCTION

The human foot and ankle contain 26 bones, 33 joints and more than a hundred muscles, tendons and ligaments. Damage to only one of these can sideline a worker.

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With so many opportunities for injury in our feet, it's not surprising that foot injuries are one of the most common types of OSHA and EU-OSHA-reportable incidents in the workplace and that they also frequently require workers to take time off the job to heal. Neither of these outcomes is good news for your organization, and of course most importantly, when the safety of workers themselves is at stake, so is your company reputation. Prevention of foot injuries, then, should always be considered an important priority. This is borne out by plenty of statistics.

For example, according to the Bureau of Labor Statistics, there are at least 60,000 foot injuries every year that result in time off work; there are thousands more that result in lower productivity or the need to change job assignments for workers for some period of time. This means that on average, there are 6 people per 10,000 full-time workers missing work on any given day due to foot injuries. The average cost of one of those lost workdays is $9,600. When it comes to workers' compensation, foot injuries are among the most common claims, with a study of over 250,000 workers' comp claims finding that the average final settlement for a foot injury is more than $17,000.

According to the European Agency for Safety and Health at Work (https://www.researchgate.net/publication/224022748_OSH_in_Figures_Work-related_Musculoskeletal_Disorders_in_the_EU_-_Facts_and_Figures), the European countries with the most accidents per 100,000 employees are Portugal, France, Spain, Luxembourg, and Germany. Back problems are the most commonly reported work-related health problem (affecting almost one third of respondents), followed by neck, shoulder and arm problems and then hip, leg or foot problems (reported by 16.3 % of workers). Changes to the type of footwear worn by workers is listed as a one of more than a dozen commonly used task-specific interventions in work-related musculoskeletal disorders in Australia (https://www.safeworkaustralia.gov.au/system/files/documents/1912/work-related_musculoskeletal_disorders_in_australia_0.pdf). In India and Southeast Asia, where going barefoot is still common in many jobs, roadside accident was the most common type of (in over 70% of reported food injuries), but injuries from falls, the fall of a heavy object on a foot, and machine injuries were also common, especially in young men in their working prime (https://www.jpmer.com/doi/JPMER/pdf/10.5005/jp-journals-10028-1032) . In many foot-specific cases, injuries can often be linked to injuries in other parts of the body due to the inter-related nature of all parts of the human musculoskeletal structure.

Many of these injuries are caused by falling objects striking workers' feet, but not terribly heavy objects falling from far above: the average weight of an object that causes foot injury is less than almost 30 kg (over half weigh less than about 13.5 kg), and the height from which it falls is less than four feet. The next most frequent causes of foot injuries are puncture wounds, followed by what might appear to be common slips, trips, and falls. However, the National Safety Council reports that there are nearly 45 million of these "common" slips, trips, and falls every year, costing companies $968 billion.

Worst of all, foot injuries can result in permanent disabilities, such as partial or complete loss of mobility. This can impact how workers can continue do their jobs, if they are able to return to work at all. Clearly, foot injuries are serious business, and need to be addressed as completely and unambiguously as possible.

STANDARDS CAN HELP

The impact related to the sheer volume of foot injuries can seem daunting when it comes to ensuring that your workers have the most applicable protection possible. That's where standards earn their stars: they make your job easier because the important work of testing and deciding what's best to prevent these types of injuries has been done for you.

TO BEGIN, HERE ARE SIX COMMMON WORK-RELATED FOOT INJURIES AND THEIR CAUSES AS IDENTIFIED BY OSHA:

- Mechanical risks, such as shocks and punctures
- Chemical risks, including acids, oils, hydrocarbons and other substances
- Electrical risks due to ESD or inadequate insulation
- Risks that are linked to movements like slips, falls, and sprains
- Thermal injuries related to too hot or too cold environments
- Biological risks such as allergies or other irritations

Other hazards include temperature extremes (excessive heat can cause skin conditions and while extreme cold can result in hypothermia or frostbite that require amputation of feet or toes) and even "just" standing for extended periods, which contributes to cumulative foot injuries like bunions, corns, and fallen arches. Additional foot injury hazards also frequently exist for specific types of jobs such as construction, logging, hydro linework and process control facilities.

WORLDWIDE ACCEPTANCE

Originating in the late 1980s, standardization of protection requirements for PPE (personal protective equipment) footwear is almost completely unified; all European standards are also ISO (worldwide) standards.

One standard, EN ISO 20344, compiles all the tests that can be performed on PPE footwear, and more than 90% of the footwear requirements for the world market is based on only two performance standards:

- EN ISO 20345, safety footwear (85%)
- EN ISO 20347, occupational footwear (5%)

All other PPE footwear standards are customized for specific industries but are based on these two.

As new materials have begun to be used in footwear more frequently, the need for an update to the standards became apparent and was conducted in 2022 (the last update was in 2011). The update included specifications for new shoe materials to protect against punctures, for example, as well as addressing workers' expectations for lighter, more attractive shoes that fit well for both men and women.

This guide includes a summary of the legislative background for the EN ISO 20345:2022 standard for safety footwear, and then provides detailed specifications for the various elements and materials of safety footwear. For a copy of the complete standard document, please visit this web page: https://www.iso.org/standard/73222.html .

WHAT IS EN ISO 20345:2022 AND WHAT LEGISLATION IS BEHIND IT?

EN ISO 20345:2022 specifies basic and additional (optional) requirements for safety footwear used for general purposes. It includes information on risks (mechanical, thermal, etc.) as well as data related to slip resistance and ergonomic behaviors. It also details requirements for safety footwear equipped with customized insocks, customized safety footwear, or individual manufactured customized safety footwear. It does not cover the property of high visibility because of interaction with the clothing (e.g. trousers cover the footwear) or work area conditions (e.g. dirt, mud).

As noted earlier, EN ISO 20345:2022 replaces an earlier standard put forth in 2011. It includes detailed standard parameters for PPE footwear to be classified as "safety" gear. The changes that appear in the updated standard are fairly extensive, with some considered to be major while others are deemed to be minor. Two of tThe primary changes from 2011 are in these areas:

- Technical: new test standards for slip resistance (EN ISO 13287) and level of protection required for toe caps and anti-puncture/perforation inserts (EN ISO 22568)
- Societal: to allow for legal coverage of orthopaedic variations

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This technical guide covers only the MAJOR updates that appear in the EN ISO 20345:2022 standard for safety footwear. To order a copy of the complete standard document, please visit this web page: https://www.iso.org/standard/73222.html

Another document related to EN ISO 20345:2022 that may be of interest is EN ISO 20344, which is a catalog of various test methods for PPE footwear intended to be worn as safety footwear. It was also updated in 2021 and a complete copy may be found at https://www.iso.org/standard/51034.html

For a comprehensive overview of the legislation that guided the creation of both EN ISO 20345:2022 and EN ISO 20344, see https://osha.europa.eu/en/safety-and-health-legislation. For further information regarding European guidance on exposure to chemical agents and chemical safety, see https://osha.europa.eu/en/legislation/guidelines/exposure_chemical_agents

Trusted manufacturers and vendor partners are also good resources for further details.

KEEP UP THE GOOD WORK!

Now that you have everything you need to choose the right safety footwear for your workers, it's important to protect your investment in them by maintaining them properly. This will not only help to facilitate longer life but also ongoing compliance with EN ISO 20345:2022.

Whenever possible, involve workers in the selection of their safety footwear; when people can choose their gear based on as many personal preferences as allowable, they are more likely to wear it as required. Workers should be trained to examine their gear before and after each wearing to ensure it is in good working order. If workers are allowed to wear their safety footwear outside work, are asked to clean their own footwear, or if you have other expectations related to how they are responsible for their gear, this should be made very clear with examples and training provided if appropriate. When not worn, safety footwear should be stored in a clean, dry environment.

An effective safety footwear maintenance process should include:

- Checking for faults, damage, dirt, wear and tear
- Cleaning to avoid build-up of dirt or other contaminants (referring to manufacturer's instructions)
- Testing for damage to important seams and surfaces
- Repair, if necessary/possible
- Clear parameters for replacement when damaged beyond repair and/or no longer in compliance with the standards they are intended to meet

Providing your workers with appropriate safety footwear is essential to ensure compliance with current regulations, improve your organization's safety and productivity, and most importantly, ensure worker protection while on the job.

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CLARIFICATION ON THE CLASSIFICATION OF SAFETY FOOTWEAR

1. CLARIFICATION ON THE CLASSIFICATION OF SAFETY FOOTWEAR

CLASS I

- Footwear made from leather and other materials, excluding all-rubber orall-polymeric footwear

CLASS II

- All-polyameric (i.e. entirely moulded) including all-rubber (i.e. entirely vulcanized) footwear

HYBRID FOOTWEAR

- Footwear that cannot be classified as footwear “Class I” or “Class II”
- There are 2 type of Hybrd footwear
- Hybrid “moulded” footwear
- Vulcanized rubber or all moulded polymeric foot section integrally moulded around the toecap and often including the outsole, which can be unlined and usually does not incorporate an insole
- Hybrid “mounted” fotwear
- Vulcanized rubber or all moulded polymeric foot section that is manufactured separately and then constructed around a conventional lasted lining/insole construction and often with a separately attached outsole

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KEY

1. Height
2. 10% of length
3. Total length of the footwear

2. HEEL AREA DEFINITION

The heel area isdefined by the rear (10 ± 2) % of the total length of the footwear (upper and outsole measured along the test axis according to EN ISO 20344:2022) and a minimum height given in table 8 (Height, below which upper requirement apply) for design A.

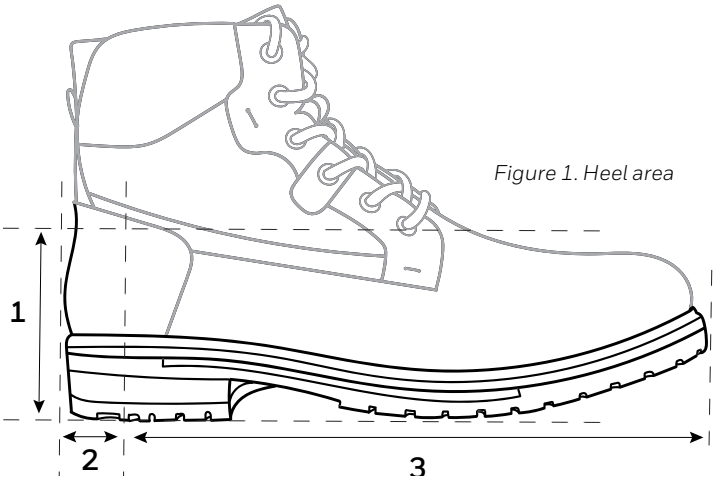

Figure 1. Heel area

3. TOE PROTECTION

3.1 TYPES OF TOECAPS

Several types of toecaps are available for the choice of the footwear manufacturer:

- Metallic
- Non-metallic
- Type A
- Type B

For “Type A” or “Type B” toecap no extra test related with the EN ISO 20345:2022 are needed and no changes on the minimum clearance under toecap for metallic and non-metallic toecap type A or B.

3.2 FLANGE OF TOECAP

The flange of metallic toecap shall not be greater than 12 mm for metallic toecap and 15 mm for non-metallic toecap. It was 10 mm on the old version for metallic and non-metallic toecap.

4. SLIP RESISTANCE

4.1 BASIC SLIP RESISTANCE TESTING

Slip resistance will be for the basic requirements on ceramic tile floor with sodium lauryl sulphate (NaLS) solution. Two test conditions are needed:

- Forward heel slip with a coefficient of friction ≥ 0.31
- Backward forepart slip with a coefficient of friction ≥ 0.36

4.2. SLIP RESISTANCE ON CERAMIC TILE WITH GLYCERINE

Slip resistance on ceramic tile with glycerine shall fulfil the following requirements:

- Forward heel slip with a coefficient of friction ≥ 0.19
- Backward forepart slip with a coefficient of friction ≥ 0.22

4.3. SPECIAL FOOTWEAR

For footwear designed for special footwear purpose containing spikes, metal studs or similar and for use for very special work places (soft ground e.g. sand, sludge, forestry timber, etc.) this test is not applicable. This footwear is marked with symbol “ø” (for not tested) according with this standard.

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5. SEAM STRENGTH

For hybrid footwear, when material A and B may be connected by stitching, welding or other suitable methods, the connection shall fulfil a strength of at least 10 N/mm.

6. WATER VAPOUR PERMEABILITY AND COEFFICIENT

A maximum area of 10 % of non-water vapour permeable materials is accepted. If the upper contains an area of maximum 25 % of non-water vapour permeable material, the remaining materials shall fulfil a water vapour permeability of at least 2.0 mg/(cm2.h).

7. OUTSOLE

All basic outsole requirements shall be tested on materials in contact with the floor during footwear usage. Testing materials of the outsole, not in contact with the floor, is not compulsory.

8. PENETRATION RESISTANCE

8.1. METALLIC INSERT

No changes on the requirements.

8.2. NON-METALLIC INSERT

8.2.1. TYPE PL

Nail with 4.5 mm of diameter.

No perforation shall occur at any of the 4 measurements and no separation of the layers shall occur during all tests.

KEY

1. Ground
2. H, lowest point of the area A and ground
3. Area A
4. Area B

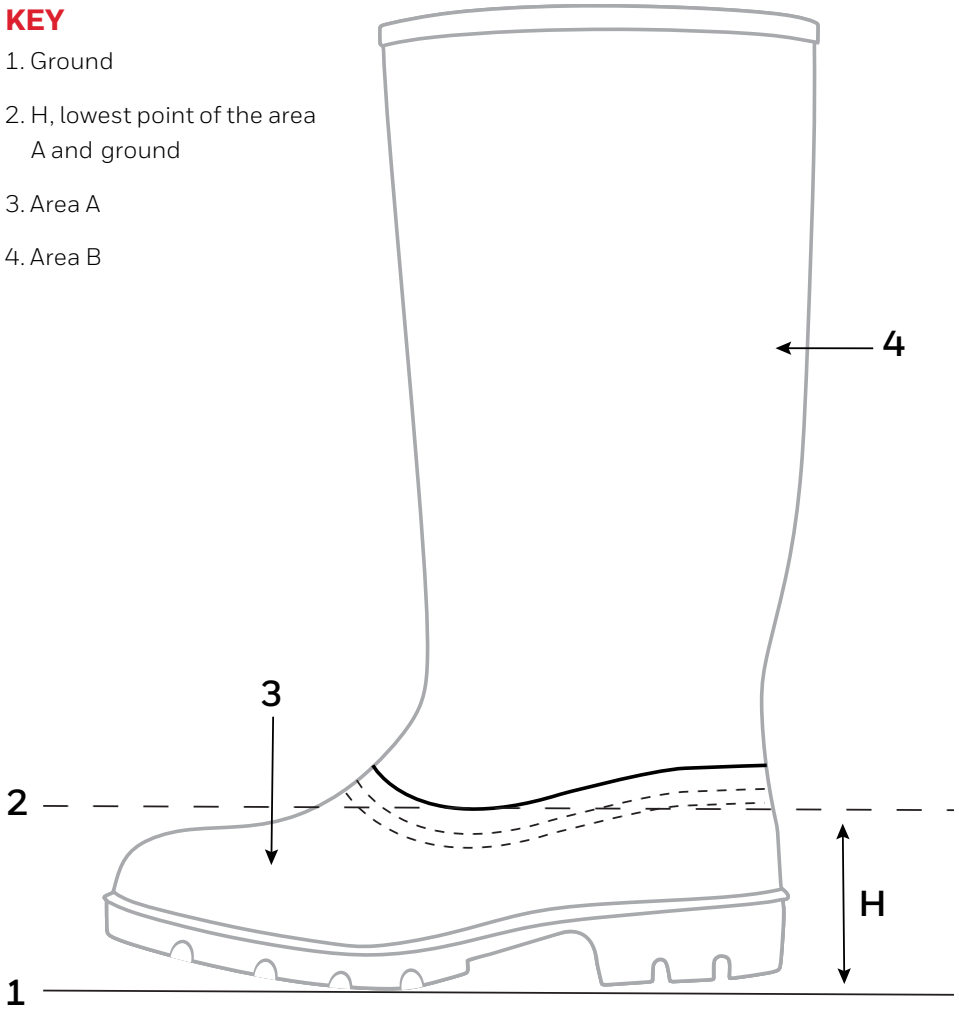

Figure 2. Seam strength

Identical as today test for non-metallic inserts. similar and for use for very special work places (soft ground e.g. sand, sludge, forestry timber, etc.) this test is not applicable. This footwear is marked with symbol "ø" (for not tested) according with this standard.

8.2.2. TYPE PS

Nail with 3 mm of diameter.

Average value of the force required to perforate the outsole unit shall be not less than 1100 N and no single value shall be lower then 950 N.

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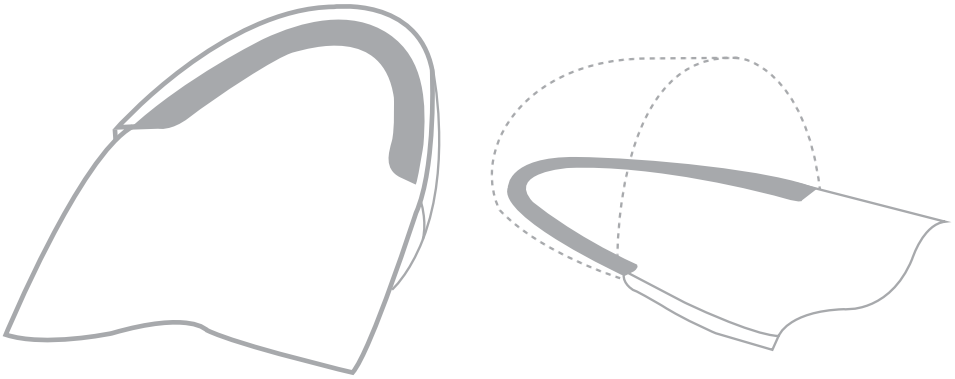
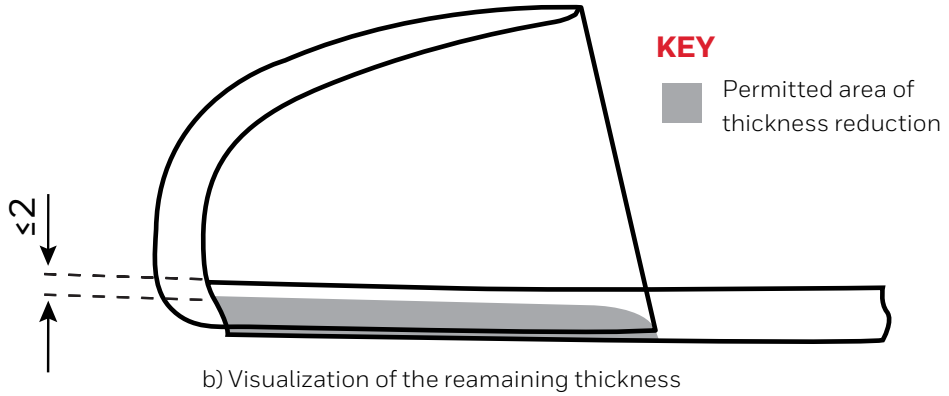
8.2.3. CONSTRUCTION

Non-metallic insert that also function as an insole:

- May lie above the flange of the safety toecap
- Shall not be skived apart from where they are covering the flange of the toecap maintening a minimum thickness of 2 mm in the skived area.



a) Area of toecap flange



b) Visualization of the reamaining thickness

Figure 3. Skived area above the toecap

9. METARTASAL PROTECTION

The metartasal protective device shall fit the shape of the footwear at the inner and outer side of the foot and the device shall overlape the toecap by a minimum of 5 mm and lean on it.

10. ANKLE PROTECTION

The ankle areas shall protected at least on the outer side of the footwear. Additional protection on the inner side is optional.

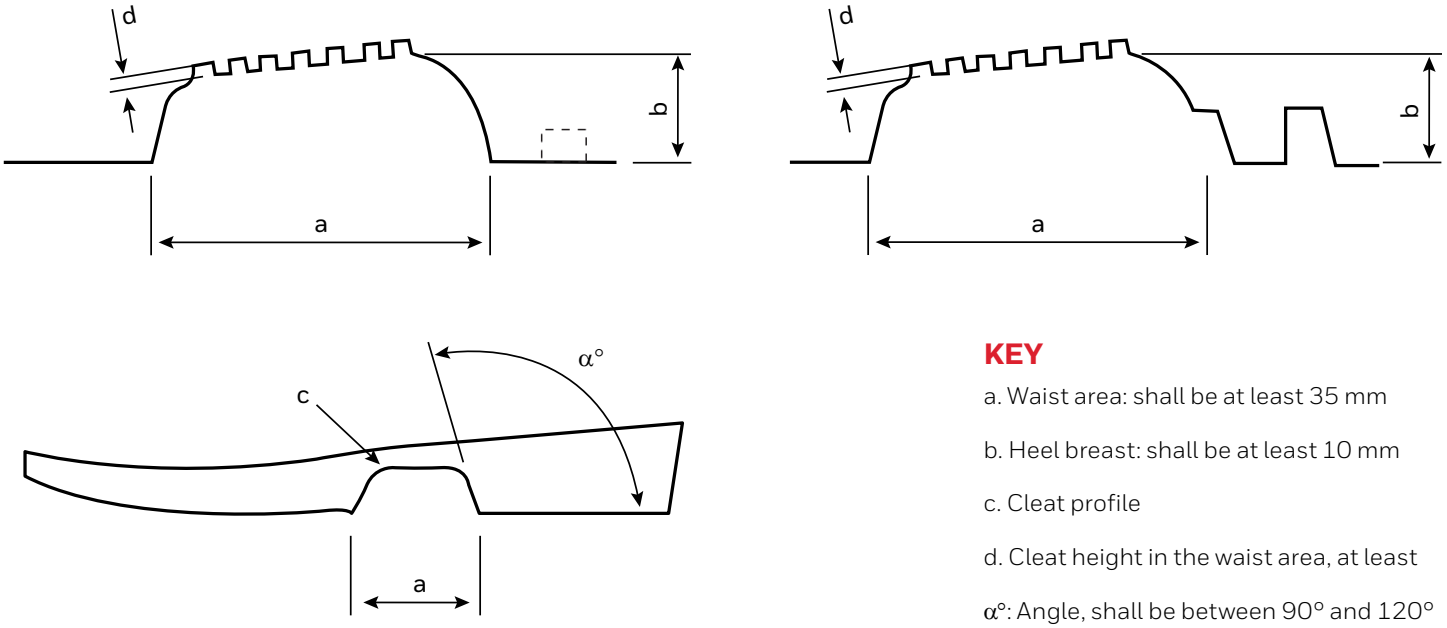
11. SCUFF CAP ABRASION

Any scuff cap need to pass the abrasion test. Shall not develop any hole through the full thickness before 8000 cycles.

Oliver 55

12. LADDER GRIP

All material in contact with a ladder rung shall fulfil the requirements for abrasion on the outsole.



KEY

a. Waist area: shall be at least 35 mm

b. Heel breast: shall be at least 10 mm

c. Cleat profile

d. Cleat height in the waist area, at least

α°: Angle, shall be between 90° and 120°

Figure 3. Ladder grip

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13. MARKING CATEGORY OF SAFETY FOOTWEAR

TABLE 2. MARKING CATEGORY

CATEGORY	BASIC REQUIREMENTS	ADDITIONAL REQUIREMENTS
SB	Class I or II	
S1	Class I	As SB, plus Closed heel area Energy absorption of seat region Antistatic
S2	Class I	As S1 plus Water penetration and absorption
S_3 (metal insert type P) or **S_3L (non-metal insert type PL) or** **S_3S (non-metal insert type PS)**	Class I	As S2 plus Perforation resistance according to the type Cleated outsole
S4	Class II	As SB, plus Closed heel area Energy absorption of seat region Antistatic
S5	Class II	As S4 plus Perforation resistance according to the type Cleated outsole
S6	Class I	As S2 plus Water resistance of the whole footwear
S7 (metal insert type P) or **S7L (non-metal insert type PL) or** **S7S (non-metal insert type PS)**	Class I	As S3 plus Water resistance of the whole footwear

Note 1: For ease of marking, this table categorizes safety footwear with the most widely used combination of basic and additional requirements.

Note 2: If the footwear is not tested against slip resistance requirement, it is marked with the symbol "Ø"

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14. ADDITIONAL REQUIREMENTS

TABLE 2. ADDITIONAL REQUIREMENTS

REQUIREMENTS		CLAUSE OF THE STANDARD	CLASSIFICATION				SYMBOL
			CLASS I	CLASS II	HYBRID		
					MOUNTED	MOULDED	
Whole footwear	**Perforation resistance (metal insert type P)a** **Perforation resistance (non-metal insert)** **Type PL[a]** **Type PS[a]**	6.2.1	X	X	X	X	PL
	Electrical properties:	6.2.2					
	Partially conductive footwear	6.2.2.1	X	X	X	X	C
	Antistatic footwear	6.2.2.2	X	X	X	X	A
	Resistance to inimical environments:	6.2.3					
	Heat insulation of outsole complex	6.2.3.1	X	X	X	X	HI
	Cold insulation of outsole complex	6.2.3.2	X	X	X	X	CI
	Energy absorption of seat region	6.2.4	X	X	X	X	E
	Water resistance	6.2.5	X				WR
	Metartasal protection	6.2.6	X	X	X	X	M
	Ankle protection	6.2.7	X	X	X	X	A
	Cut resistance	6.2.8	X	X	X	X	CR
	Scuff cap abrasion	6.2.9	X				SC
	Slip resistance: **On ceramic tile floor with glycerine**	6.2.10	X	X	X	X	SR
Upper	**Water penetration and absorption**	Class II	X				WPA
Outsole	**Resistance to hot contact**	Class II	X	X	X	X	HRO
	Resistance to fuel oil	Class I	X	X	X	X	FO
	Ladder Grip	Class I	X	X	X	X	LG

a – One of the three shall be chosen

b – One of the two shall be chosen

Note: The applicability of a requirement to a particular property is indicated in this table by X

15. NEW LABEL EXAMPLE

TABLE 3. LABEL EXAMPLES

LABEL	SAFETY SHOE PROPERTIES	
	• Steel penetration resistance • Slip resistance in ceramic tile with NaLS • Closed heel area	• Antistatic • Water penetration and absorption (WPA) • Energy absorption of seat region
	• Steel penetration resistance • Slip resistance in ceramic tile with NaLS • Closed heel area • Energy absorption of seat region	• Antistatic • Water penetration and absorption (WPA) • **Resistance to fuel oil (FO)**
	• Steel penetration resistance • Slip resistance in ceramic tile with NaLS • Closed heel area • Energy absorption of seat region	• Antistatic • Water penetration and absorption (WPA) • **Resistance to fuel oil (FO)** • Water resistance of the whole footwear (WR)
	• Non-metallic penetration resistance with 3 mm nail • Slip resistance in ceramic tile with NaLS • Closed heel area • Energy absorption of seat region	• Antistatic • Water penetration and absorption (WPA) • Resistance to fuel oil (FO) • Water resistance of the whole footwear (WR)
	• Non-metallic penetration resistance with 4.5 mm nail • Slip resistance in ceramic tile with NaLS • Closed heel area • Energy absorption of seat region • Antistatic • Heat insulation of the outsole complex (HI) • Metartasal protection (M) • Slip resistance on ceramic tile with glycerine (SR)	• Cold insulation of the outsole complex (CI) • Ankle protection (AN) • Scuff cap abrasion (SC) • Cut resistance (CR) • Resistance to hot contact (HRO) • Resistance to fuel oil (FO) • Ladder grip (LG) • Water resistance of the whole footwear (WR)

REFERENCES

ISO. (2022, December). International Standard - ISO 20345:2022. Personal Protective Equipment - Safety footwear. ISO.

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