Designation: F2413 – 11

Standard Specification for Performance Requirements for Protective (Safety) Toe Cap Footwear[1]

This standard is issued under the fixed designation F2413; 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 (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the U.S. Department of Defense.

INTRODUCTION

For more than sixty years, the predecessor to this specification, ANSI Z41, established the performance criteria for a wide range of footwear to protect from hazards that affect the personal safety of workers.

The value of these standards was recognized early in the history of Occupational Safety and Health Administration (OSHA) and incorporated as a reference standard in the Code of Federal Regulations (29 CFR Part 1910.132 and 29 CFR Part 1910.136).

The principal purpose of this standard is the certification of protective footwear. Certification must be performed by independent third party laboratories in order for footwear to bear the ASTM marking.

The specification contains performance requirements for footwear to protect workers' feet from the following hazards by providing: (*1*) impact resistance (I) for the toe area of footwear; (*2*) compression resistance (C) for the toe area of the footwear; (*3*) metatarsal impact protection (Mt) that reduces the chance of injury to the metatarsal bones at the top of the foot; (*4*) conductive properties (Cd) which reduce hazards that may result from static electricity buildup; and reduce the possibility of ignition of explosives and volatile chemicals; (*5*) electric hazard protection (EH), to protect the wearer when accidental contact is by stepping on live electric wires; (*6*) static dissipative properties (SD) to reduce hazards due to excessively low footwear electrical resistance that may exist where SD footwear is required; and (*7*) puncture resistance (PR) footwear devices.

1. Scope

1.1 This specification covers minimum requirements for the performance of footwear to provide protection against a variety of workplace hazards that can potentially result in injury.

1.2 This specification is not intended to serve as a detailed manufacturing or purchasing specification, but can be referenced in purchase contracts to ensure that minimum performance requirements are met.

1.3 Controlled laboratory tests used to determine compliance with the performance requirements of this specification shall not be deemed as establishing performance levels for all situations to which individuals may be exposed.

1.4 Any changes to the original components of safety toe footwear such as replacing or adding after market footbeds/inserts could cause failure to any or all parts of this standard rendering the ASTM marking invalid.

1.5 This specification is not applicable to overshoes with safety toe caps or strap on devices with safety toes.

1.6 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

1.7 *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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

B117 Practice for Operating Salt Spray (Fog) Apparatus

[1] This specification is under the jurisdiction of ASTM Committee F13 on Pedestrian/Walkway Safety and Footwear and is the direct responsibility of Subcommittee F13.30 on Footwear.

Current edition approved July 1, 2011. Published August 2011. Originally approved in 2005. Last previous edition approved in 2005 as F2413 – 05. DOI: 10.1520/F2413-11.

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

F1646 Terminology Relating to Safety and Traction for Footwear
F2412 Test Methods for Foot Protection
2.2 *Federal Standards:*[3]
29 CFR Part 1910.132 Personal Protective Equipment–General Requirements
29 CFR Part 1910.136 Personal Protective Equipment–Occupational Foot Protection
2.3 *Canadian Standards Association Standard:*[4]
CAN/CSA Z195 Protective Footwear

3. Terminology

3.1 *Definitions:*

3.1.1 *insert/footbed/sockliner (all removable), n*—footbed normally made of a foam product with leather or fabric cover shaped to cover the entire insole which can be inserted between the foot and insole board.

3.1.2 *insole, n*—foundation of the shoe; the inner sole of the shoe which is next to the foot, under the sock liner or the insert, onto which the upper is lasted.

3.1.3 *last, n*—solid hinged form, in the general shape of a foot, around which footwear is constructed.

3.1.4 *lasting, v*—building of footwear around a specific foot last.

3.1.5 *lining, n*—term used to describe all components that can be used to construct the interior of the upper part of the footwear.

3.1.6 *soling material, n*—exterior bottom platform of the footwear; the bottom surface.

3.1.7 *product category, n*—description for a type of footwear designed and manufactured for a specific hazard or hazards.

3.1.8 *protective footwear, n*—footwear that is designed, constructed, and classified to protect the wearer from a potential hazard or hazards.

3.1.9 *protective toe cap, n*—component designed to provide toe protection that is an integral and permanent part of the footwear.

3.1.10 *quarter, n*—entire back portion of the footwear upper.

3.1.11 *size, n*—length and breadth measurements of footwear determined by using a specific grading; the American system of footwear grading.

3.1.12 *socklining (non-removable), n*—material placed over the insole, footbed, or insert that may be imprinted with a brand name or other designation.

3.1.13 *upper, n*—parts of a shoe or boot that are above the bottom of the foot.

4. Significance and Use

4.1 This specification contains requirements to evaluate the performance of footwear for the following:

4.1.1 Impact resistance for the toe area of footwear, (I),

4.1.2 Compression resistance for the toe area of footwear, (C),

4.1.3 Metatarsal protection that reduces the chance of injury to the metatarsal bones at the top of the foot, (Mt),

4.1.4 Conductive properties which reduce hazards that may result from static electricity buildup, and reduce the possibility of ignition of explosives and volatile chemicals, (Cd),

4.1.5 Electric hazard by stepping on live wire, (EH),

4.1.6 Static dissipative (SD) properties to reduce hazards due to excessively low footwear electrical resistance that may exist where SD footwear is required, and

4.1.7 Puncture resistance footwear devices, (PR).

4.2 Any changes to the original components of the safety toe footwear such as replacing or adding after market footbeds/inserts could cause failure to any or all parts of this standard rendering the ASTM MARKING INVALID. Protective toe footwear specimens or samples shall be retested for any of the following changes:

4.2.1 Change in material used to make protective toe cap, change in protective cap manufacturer, change in the design of the toe cap.

4.2.2 Change in construction method used to make footwear or change in factory in which footwear is produced.

4.2.3 Change in the upper or insole material thickness greater than 25 %, change to the soling system, or a change in the hardness of the outsole.

4.2.4 Change in shape of last used in the manufacturing of footwear.

4.2.5 Change in material or supplier of protective insole.

4.2.6 Change in material or supplier of the metguard.

5. Performance Requirements for Foot Protection

5.1 *Impact Resistant Footwear (I):*

5.1.1 Impact resistant footwear shall also meet the requirements of 5.2 for compression resistant footwear.

5.1.2 Footwear shall be constructed and manufactured so that a protective toe cap is an integral and permanent part of the footwear. This type of footwear is to be worn over the foot only. Overshoes and overboots, including strap on devices with protective toe caps that are meant to be worn over footwear, do not comply with the requirements of this standard. Therefore they can not be marked with ASTM F2413 designation.

5.1.3 The workmanship in the production and assembly of the footwear shall ensure that the footwear provides functionality to the wearer.

5.1.4 Impact 75 shall be determined by evaluating three specimens in accordance with Test Methods F2412. The requirement for impact resistance represents the minimum force required that results in the toe area of the footwear having a minimum interior height clearance of 12.7 mm (0.50 in.) in men's footwear and 11.9 mm (0.468 in.) in women's footwear.

5.1.4.1 Impact resistance of footwear shall be as follows:

(1) Impact 75 product for men's footwear shall demonstrate a minimum interior height clearance of 12.7 mm (0.50 in.) during exposure to impact energy of 101.7 J (75 ft-lbf).

[3] Available from U.S. Government Printing Office Superintendent of Documents, 732 N. Capitol St., NW, Mail Stop: SDE, Washington, DC 20401.

[4] Available from Canadian Standards Association (CSA), 178 Rexdale Blvd., Toronto, ON Canada M9W1R3.

(2) Impact 75 product for women's footwear shall demonstrate a minimum interior height clearance of 11.9 mm (0.468 in.) during exposure to impact energy of 101.7 J (75 ft-lbf).

5.1.4.2 Each protective toe cap shall bear the manufacturer's name or trademark or logo. Cap number or identification, and toe cap size and R (right) or L (left) shall be permanently stamped or marked in a conspicuous location.

5.1.4.3 Any specimen that does not meet the minimum impact performance requirements for Impact 75 constitutes non-compliance for the product category.

5.2 *Compression Resistant Footwear (C):*

5.2.1 Compression resistant footwear shall also meet the requirements of 5.1 for impact resistant footwear.

5.2.2 Footwear shall be constructed and manufactured so that a protective toe cap is an integral and permanent part of the footwear. This type of footwear is to be worn over the foot only. Overshoes and overboots, including strap on devices with protective toe caps that are meant to be worn over footwear, do not comply with the requirements of this standard. Therefore they can not be marked with the ASTM F2413 designation.

5.2.3 The workmanship in the production and assembly of the footwear shall ensure that the footwear provides functionality to the wearer.

5.2.4 Compression 75 shall be determined by evaluating three specimens in accordance with Test Methods F2412. The requirement for compression resistance represents the minimum force required that results in the toe area of the footwear having a minimum interior height clearance of 12.7 mm (0.50 in.) in men's footwear and 11.9 mm (0.468 in.) in women's footwear.

5.2.4.1 Compression resistance of footwear shall be as follows:

(1) Compression 75 product for men's footwear shall demonstrate a minimum interior height clearance of 12.7 mm (0.50 in.) during exposure to a compressive force of 11 121 N (2500 lbf).

(2) Compression 75 product for women's footwear shall demonstrate a minimum interior height clearance of 11.9 mm (0.468 in.) during exposure to a compressive force of 11 121 N (2500 lbf).

5.2.4.2 Each protective toe cap shall bear the manufacture's name or trademark or logo. Cap number or identification and toe cap size and R (right) or L (left) shall be permanently stamped or marked in a conspicuous location.

5.2.4.3 Any specimen that does not meet the minimum compression performance resistance requirement for Compression 75 constitutes a non-compliance for the product category.

5.3 *Metatarsal Protective Footwear (Mt):*

5.3.1 Metatarsal protective footwear shall first meet the requirements of 5.1 for impact resistant footwear and 5.2 for compression resistant footwear.

5.3.2 Footwear shall be constructed and manufactured so that a metatarsal impact guard is positioned partially over the protective toe cap and extended to cover the metatarsal bone area. The metatarsal protection shall be an integral and permanent part of the footwear.

5.3.3 Mt 75 shall be determined by evaluating three specimens in accordance with Test Methods F2412.

5.3.3.1 Mt 75 metatarsal protective footwear for men shall first meet the performance requirements for Impact 75 Resistant and Compression 75 Resistant footwear. Subsequent to meeting these performance requirements, the height of the wax form used to measure metatarsal protection shall be a minimum of 25.4 mm (1.0 in.) after exposure of impact energy of 101.7 J (75 ft-lbf).

5.3.3.2 Mt 75 metatarsal protective footwear for women shall first meet the performance requirements for Impact 75 Resistant and Compression 75 Resistant footwear. Subsequent to meeting these performance requirements, the height of the wax form used to measure metatarsal protection shall be a minimum of 23.8 mm (0.937 in.) after exposure of impact energy of 101.7 J (75 ft-lbf).

5.3.3.3 Each metatarsal device shall bear the manufacturer name or trademark or logo and device number or identification and should be stamped or marked in a conspicuous location.

5.3.3.4 Any specimen that does not meet the metatarsal impact resistance performance requirement constitutes a non-compliance for the product category.

5.4 *Conductive Protective Footwear (Cd):*

NOTE 1—Conductive footwear is not intended to be worn by personnel working near open electrical circuits.

5.4.1 Conductive footwear shall also meet the requirements of 5.1 for impact resistant footwear and 5.2 for compression resistant footwear.

5.4.2 Conductive protective Footwear shall be constructed, and manufactured to provide protection through conductance with a maximum 500 000 Ω resistance for the wearer against hazards that may result from static electricity buildup and to reduce the possibility of ignition of explosives such as munitions manufacturer.

5.4.2.1 Footwear shall dissipate static electricity from the body to reduce the possibility of ignition of volatile compounds.

5.4.2.2 Footwear shall be of a construction that facilitates a stable electrically conductive path. All external components shall be made of non-metallic materials.

5.4.3 Conductive protective footwear shall be determined by evaluating three specimens in accordance with Test Methods F2412.

5.4.4 The specimens shall demonstrate resistance between 0 and 500 000 Ω.

5.4.5 Any specimen or sample of conductive footwear that does not meet the performance requirement constitutes a non-compliance for the product category.

5.5 *Electric Hazard Resistant Footwear (EH):*

NOTE 2—Electrical hazard protection is severely deteriorated in the following conditions : excessive wear on the soling material or exposure to wet and humid environments or both. Work footwear can become contaminated with conductive materials. For example, soles can pick up metal shavings, etc., which may reduce the effectiveness of the protection. **In step potential environments, dielectric overshoes should be used.**

5.5.1 Electric hazard resistant footwear shall also meet the requirements of 5.1 for impact resistant footwear and 5.2 for compression resistant footwear.

5.5.2 Electric hazard footwear shall be constructed and manufactured so that the footwear outsole can provide a SECONDARY SOURCE OF ELECTRIC HAZARD PROTECTION TO THE WEARER AGAINST THE HAZARDS BY STEPPING ON LIVE ELECTRICAL CIRCUITS, ELECTRICALLY ENERGIZED CONDUCTORS, PARTS OR APPARATUS.

5.5.3 Electric hazard resistance shall be determined by evaluating three specimens in accordance with Test Methods F2412.

5.5.3.1 Protective footwear constructed or manufactured to be resistant is capable of withstanding the application of 18 000 V (root mean square (rms)) at 60 Hz for 1 min with no current flow or leakage current in excess of 1.0 mA under dry conditions tested as per lab conditions in Test Methods F2412.

5.5.4 Any specimen that does not meet the minimum electrical hazard resistant requirements for the product constitutes a non-compliance for the product category.

5.6 *Static Dissipative Footwear (SD):*

NOTE 3—The inconsistency of certain hygroscopic materials can result in footwear not being able to consistently meet the performance requirements of static dissipative footwear.

5.6.1 Static dissipative footwear shall also meet the requirements of 5.1 for impact resistant footwear and 5.2 for compression resistant footwear.

5.6.2 Static dissipative footwear shall be constructed and manufactured to provide protection through conduction and resistance to the wearer against hazards which may exist due to excessively low footwear resistance in a work environment, as well as maintain a sufficiently high level of resistance to reduce the possibility of electrical shock in work areas where SD footwear is worn such as electrical assembly.

5.6.2.1 Footwear shall reduce the excess static electricity by conducting the charge (from body) to ground while simultaneously maintaining a sufficiently high level of resistance (10^6 ohms) (1 megohm) to protect the wearer when exposed to hazards by stepping on live electric circuits.

5.6.2.2 Using human subjects, a pair of footwear shall have a lower limit of electrical resistance of 10^6 Ω (1 megohm) and have an upper limit electrical resistance of 10^8 Ω (100 megohms) when tested at 50 V per Test Methods F2412.

5.6.3 The footwear shall use any combination of materials that facilitate static dissipation by a consistent path of resistance.

5.6.3.1 Nailed heels shall be attached using non-ferrous heel nails. These nails shall be recessed within the tread surface and then covered with conductive material so they are neither exposed nor visible.

5.6.4 Static dissipation shall be determined by evaluating three pair of specimens in accordance with Test Methods F2412.

5.6.4.1 Any specimen that does not meet the static dissipative requirements for the product constitutes a non-compliance for the product category.

5.7 *Puncture Resistant Footwear (PR):*

5.7.1 Puncture resistant footwear shall also meet the requirements of 5.1 for impact resistant footwear and 5.2 for compression resistant footwear.

5.7.2 Footwear shall be constructed, and manufactured so that a puncture resistant device is positioned between the foot and outsole or used as the insole and is made an integral and permanent part of the footwear during the manufacturing process.

5.7.3 Puncture resistant footwear shall be determined by evaluating three puncture resistant devices in accordance with Test Methods F2412.

5.7.4 The puncture resistant components shall reduce the possibility of injury caused by sharp objects that can penetrate the bottom assembly of the footwear. Testing orientation of the puncture resistant device is per manufacturer recommendation.

5.7.5 The puncture resistant device shall cover the maximum area of the foot bottom that is allowed by the construction of the footwear.

5.7.6 When viewed at a 90° angle, the puncture resistant device shall pass if the tip of the test pin does not visually penetrate beyond the face of the material nearest the foot, after an applied force of 1200 N (270 lbf).

5.7.7 Measure flex resistance to cracking using CAN/CSA Z195.

5.7.7.1 Puncture resistant devices shall show no signs of de-lamination of layers or cracking after 1.5 million flexes.

5.7.8 Puncture resistant devices shall show no sign of corrosion, de-lamination, or deterioration after being exposed to a 5 % salt solution for 24 h, in accordance with Practice B117.

5.7.9 Each puncture resistant protective device shall bear the manufacturer's name or trademark or logo, and device number or identification and be permanently stamped or marked in a conspicuous location.

5.7.10 Any specimen that does not meet minimum puncture resistant requirements for the product constitutes a non-compliance for the product category.

6. Labeling and Identification

6.1 Labeling and identification of protective footwear with protective toe cap is essential to ensure the wearer that footwear meets the required minimum performance of this specification (see Table 1).

TABLE 1 Examples of Marking and Identification

	Identification	Description
	Example A	
Line 1	ASTM F2413–11	Protective footwear that complies with the performance requirement of F2413 issued in 2011.
Line 2	F I/75/C/75	Footwear worn by female worker which has Impact 75 resistance and Compression 75 resistance.
Line 3	EH	Metatarsal 75 impact resistance and the outsole and heel of this footwear is made with non-conductive materials, electrical hazard resistant.
	Example B	
Line 1	ASTM F2413–11	Protective footwear that complies with the performance requirement of F2413 issued in 2011.
Line 2	M I/75/C/75	Footwear worn by male worker which has Impact 75 resistance and Compression 75 resistance.
Line 3	Cd	Footwear is conductive.

6.1.1 The label can be either a stitched in, stamped, or pressure sensitized label or a combination of these methods. A specific four line format that identifies the type of footwear and the hazards for which it is designed to provide protection should be used. The identification shall be enclosed in a rectangular border and be placed on the inside or outside surface of either the tongue, gusset, shaft or quarter lining in one half pair.

6.1.2 Print size on labels shall be clearly visual to the eye and shall measure 3.175 mm (0.125 in.) or larger. For example:

6.1.3 *Line 1*—Identifies that the footwear is protective footwear that complies to an ASTM standard with a specific year of issuance.

ASTM F2413	11
(ASTM Standard No.)	(Year of issuance)

6.1.4 Line 2 of label shall identify the appropriate gender and the impact and compression rating of the category.

M I/75/C/75				
M	I	75	C	75
Male	Impact Resistant Footwear	Impact Rating	Compression Resistant Footwear	Compression Rating
F I/75/C/75				
F	I	75	C	75
Female	Impact Resistant Footwear	Impact Rating	Compression Resistant Footwear	Compression Rating

6.1.5 Lines 3 and 4 have been used to reference additional sections in this standard. Section reference shall be in numerical order.

6.1.5.1 *(I)*—Identifies protection against impact as discussed in 5.1.

6.1.5.2 *(C)*—Identifies protection against compression as discussed in 5.2.

6.1.5.3 *(Mt)*—Identifies footwear designed to be impact resistant to the top of the foot as discussed in 5.3.

6.1.5.4 *(Cd)*—Identifies protection against conductive hazards as discussed in 5.4.

6.1.5.5 *(EH)*—Identifies footwear constructed with and manufactured to have electrical insulation properties; electrical hazard resistant as discussed in 5.5.

6.1.5.6 *(SD)*—Identifies footwear designed to reduce the accumulation of excess static electricity as discussed in 5.6.

6.1.5.7 *(PR)*—Identifies footwear designed to be puncture resistant as discussed in 5.7.

6.1.6 Line 4 shall be used when more than 3 sections of this standard apply to any one category.

7. Marking and Compliance Requirements

7.1 The marking as defined in this specification indicates that the protective footwear bearing this label meets the minimum requirements for the product category as defined within this specification.

7.2 *Responsibility of the Manufacturer or Supplier*—The manufacturer or supplier, or both, of the protective footwear bearing the marking shall maintain documentation to identify the product category sampled for testing, a report of tests performed, test results, date of testing, and identity of the independent testing facility used.

7.2.1 *Responsibility of Testing Facility*—The independent testing facility of record shall maintain verifiable documentation to identify the product category of protective footwear sampled for testing a report of test performed, test results, date tested, and the manufacturer or supplier, or both, of the product category tested.

7.3 *Compliance Requirements*—The manufacturer or supplier, or both, of protective footwear bearing the marking label that is found to be in non-compliance with the requirements of this specification is liable for immediate disqualification from using the ASTM label for that product category.

8. Keywords

8.1 compression resistance (C); conductive footwear (Cd); electric hazard resistance (EH); ESD; foot protection; impact resistance (I); metatarsal protection (Mt); protective footwear; puncture resistance (PR); safety footwear; static dissipative (SD)