INSULATING FOOTWEAR

RESPIREX™

THE RESPIREX™ FOOTWEAR STORY

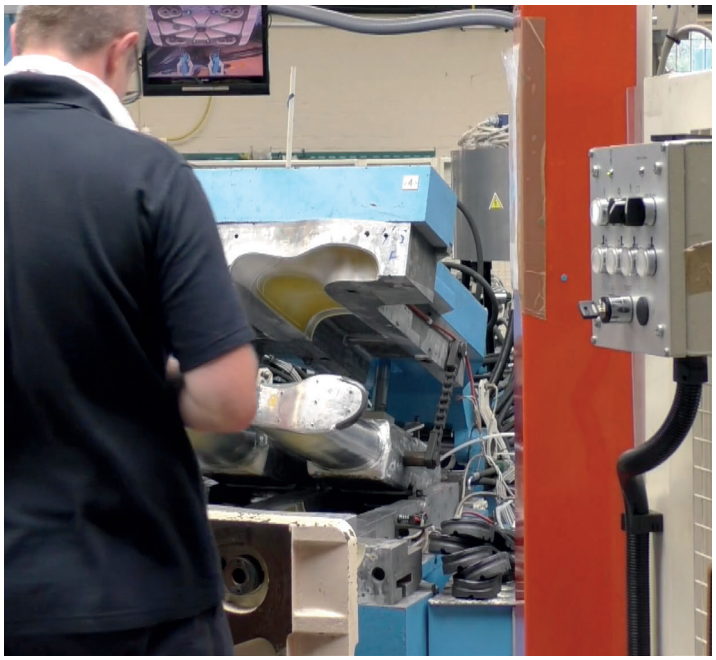
THE HIGHEST SPECIFICATIONS

Our category leading dielectric footwear is used globally to protect high voltage workers and our Kemblok™ boots are used wherever people work with dangerous or aggressive chemicals.

Respirex™ boots are manufactured at our automated state of the art footwear factory based in Crawley (in the United Kingdom). The injection molding manufacturing process guarantees a seamless, leak-free construction. This modern high-volume production facility enables the manufacture of different types and styles of boots within the same operating run, giving the flexibility to meet rapidly changing market demands.

Respirex Footwear is a division of Respirex™, a leading supplier of personal protective solutions, specializing in the design and manufacture of high-performance chemical, particulate and respiratory protective clothing.

www.respirex.com



WHY USE DIELECTRIC BOOTS?

HIGH-VOLTAGE RISKS

Electrical power plays an important role in modern society. We take it for granted and rarely think that it is dangerous, but contact with electric current can cause serious injury and or death. Protection from accidental contact with live equipment and conductors is important for those exposed to electrocution risk.

WHAT ARE DIELECTRIC BOOTS?

Dielectric (or insulating) boots are used where there is a risk of electric shock from high voltages. They provide protection because their insulating properties stop electric current from being grounded. High voltage electric current can stop the heart or produce fatal burns.

Dielectric boots are used for working on live power or in the area of live power, as current can jump large distances, especially in wet or damp conditions. There have also been fatalities caused by digging in locations where power cables are buried underground and the cable has been inadvertently cut by a drill, shovel, or with a mole.

WHAT IS SPECIAL ABOUT RESPIREX™ DIELECTRIC BOOTS?

- They are seamless, fully waterproof and their performance is not affected if they get wet
- Unlike leather boots, the performance of Respirex™ dielectric boots is not compromised by perspiration
- The wearer is always protected, unlike dielectric matting, which the user can step off unintentionally
- At 5kV (the test voltage for live working at 1kV), alternating current can jump 40mm, which is greater than the depth of a typical safety shoe sole
- Every single boot is electrically tested before it leaves the factory, ensuring the highest quality & safety
- Boots are available tested against AC or DC voltages, depending on the customer requirement

APPLICATIONS

- Power generation and distribution
- Electrified transport systems such as the Railways
- Utility companies who run the risk of cutting electric cables whilst digging or moling
- Power sub-stations were the current can jump distances (e.g. Hospitals and Shipping)
- Wind Farms
- Electric and hybrid vehicle construction, maintenance and recovery

***N.B.** Dielectric boots (as with any other item of high voltage PPE) should be used with a second barrier in case one barrier fails, typically this would be a dielectric glove.*

WHAT ABOUT THE TECHNICAL DETAILS?

INSULATING (DIELECTRIC) FOOTWEAR FOR LIVE WORKING

Insulating boots or overboots are an essential item of personal protective equipment for safeguarding workers against electric shock, ensuring that those working on, or close to, live electrical equipment are adequately protected. Dielectric footwear is used in environments including electrical power distribution equipment maintenance and repair (power lines, substations etc), renewable energy installations, electrified railway maintenance, industrial high voltage plant and equipment, construction and utilities. The current European standard for insulating footwear for high voltage live working is **EN 50321-1:2018**, which standard includes six performance classes (see below) for working at up to 36 thousand Volts (36kV).

For electrical testing the boots are filled with water and placed in a water tank, with the water inside the boots connected to one terminal of the test voltage source and the water in the tank to the other. This setup ensures a uniform electric field and accurate measurement of the insulating properties of the boot.

For boots with a penetration resistant mid-sole there is an electrical test after perforation of the sole by a nail, to ensure boots still give electrical protection after perforation.

The table below lists the classes and the test requirements:

	Maximum Working Voltage	Withstand Test Voltage	Leakage Current Test Voltage	Maximum Leakage Current
Class 00	**500V**	5kV	2.5kV	3mA
Class 0	**1kV**	10kV	5kV	5mA (8 mA)
Class 1	**7.5kV**	20kV	10kV	10mA (16 mA)
Class 2	**17.5kV**	30kV	20kV	18mA
Class 3	**26.5kV**	40kV	30kV	20mA
Class 4	**36kV**	50kV	40kV	24mA

(Overboot requirements are in brackets where they are different to knee high boots)

The new standard also includes requirements for DC current; all boots used for DC must be tested for DC according to the new standard and this is available as an option (contact us for details).

RE-TESTING DIELECTRIC FOOTWEAR

Not many people are aware that EN 50321:2018 requires that all approved dielectric footwear is re-tested one year after first use. This is why Respirex™ boots have a space to record periodic inspection testing next to the CE markings on the boot. This requirement applies to all CE marked dielectric footwear from every manufacturer - if boots are not re-tested then they are effectively no-longer compliant to the standard.

Dielectric boots under test at the Respirex™ boot factory

WHY IS LEATHER FOOTWEAR NOT SUITABLE FOR LIVE WORKING?

The standards that currently relate to footwear for live working are ASTM F1117 in the USA and EN 50321-1:2018 in Europe which is set to become an IEC (International Electrotechnical Commission) standard, making it applicable globally. Both these standards test the footwear by filling it with water and immersing in water to a set depth from the top of the boot depending on the test Voltage. A test voltage is applied and the current passing through the boot is measured. A gap is left between the water surface and the top of the footwear to insure that when the test voltage is applied, current cannot arc over the top of the footwear (as at high voltages current can jump surprisingly large distances). At 5 KV, the Class 0 test Voltage for live working at up to 1000V, the gap from the water surface to the top of the boot is specified at 40 mm inside and outside the boot, for Class 1 (with a 10kV test voltage) this gap is increased to 70 mm.

For this reason footwear with just an insulating sole cannot be used, as soles on most Industrial boots are not 40 to 70 mm (1.5 to 2.75 inches) thick.

If the upper of the footwear is leather then when leather gets wet it will conduct electricity. This applies even to waterproof leather, as this relies on a thin coating of Polyurethane over the leather which can be easily damaged during normal use/wear.

Even in dry conditions the leather will become wet due to perspiration. A typical foot perspires at a rate of 13 grams of water per hour so the leather will quickly become electrically conductive. This means that for waterproof leather footwear, the electrical insulation on the upper is reliant on a very thin layer of Polyurethane (typically 0.1 mm or less). For comparison, the wall thickness of an insulating boot is specified at > 2.5 mm. It is for this reason that both live working standards fill the footwear with water to perform the test, to ensure the footwear maintains its protection even in wet and humid conditions.

We firmly believe that only footwear that passes either EN 50321-1:2018 or ASTM F1117 should be used for live working. Leather Footwear will not pass these standards.

There are 2 reasons:

1. Electricity can jump around an insulating sole
2. Leather and some other upper materials will conduct electricity once they have absorbed perspiration or water from environment.

Standards such as ASTM F 2413 and pr EN 50321-2 are test procedures for testing Insulating soles and are not suitable for certifying footwear for live working.

For live working specify footwear that is certified to EN 50321-1: 2018 or ASTM F1117. An important part of conformance to the live working standard is that **all** footwear is electrically tested to the relevant class before it leaves the factory. The class of footwear required will be determined by the working Voltage (see the table below). If the risk is from direct rather than alternating current then specify that a DC test is performed on the footwear by the manufacturer.

	Working Voltage	Routine test Voltage	Water level from the top of the boot	Withstand test (destructive)
Class 0	Up to 1 kV	5 kV	40 mm	10 KV
Class 1	Up to7 .5 kV	10 kV	70 mm	20 KV
Class 2	Up to 17.5 kV	20 kV	90 mm	30 KV
Class 3	Up to 26.5 kV	30 kV	120 mm	40 KV
Class 4	UP to 36.5 kV	40 kV	130 mm	50 KV

THE SCIENCE OF SLIP

As part of mandatory testing for the latest edition of the EN 20345:2022+A1:2024 standard, footwear is tested for forward heel slip resistance and backward forepart (ball of the foot) slip resistance at a 7° angle on a ceramic floor tile with a soapy water (Sodium Lauryl Sulphate) solution.

An additional, more demanding test, using glycerol oil on a ceramic tile (to simulate an oily/greasy floor) can be performed; the test measures backward slip on the ball of the foot with the heel raised and forward heel slip at a 7° angle and boots that pass this additional test can be marked **SR**.

These tests replace the previous **SRA** and **SRB** tests in the 2011 version of the EN 20345 standard. **SRA** testing was similar to the mandatory test in the current standard and was assessed using soapy water on a ceramic tile. The **SRB** test used oil (Glycerol) on a steel plate; this test had a very low pass/fail limit and the error in measurement was +/- 50%. The pass value is so low that the probability of a fall in this environment is still high, which is why this test has now been replaced. The **SRC** marking in the 2011 standard indicated that boots had passed both **SRA** and **SRB** tests.

The vulcanized rubber sole on Respirex™ boots produces very high levels of slip resistance with soapy water on a ceramic tile (the most common use case scenario), and these test results have been confirmed during customer wear tests. Due to the performance characteristics of the sole material, boots with our vulcanized rubber sole also achieve a pass on the new **SR** (glycerine on a ceramic tile) test and the previous **SRB** (oil on steel test). Boots with a vulcanized sole that have been assessed to the new standard are marked EN 20345:2022+A1:2024 **SR**, boots that have not yet been reassessed are marked EN 20345:2011 **SRC**.

Note: Some manufacturers add rubber to PVC to improve its resistance to fuel & oil, but this is not the same as a vulcanized sole and does not improve slip performance.

BENEFITS OF A VULCANIZED RUBBER SOLE

Over 30% of industrial accidents result from slips, trips and falls - as Respirex™ boots are frequently used in environments where there are liquids present a slip resistant sole is crucial, which is why we provide the option of a high-performance vulcanized rubber sole on our boots.

This provides a number of important benefits:

- Grip is 30% better than with a conventional safety boot sole
- Wear resistance is 2 to 3 times that of conventional soles
- Non marking vulcanized nitrile rubber compound
- The sole is resistant to fuel and oil
- Greater cut resistance than conventional soles
- Resistant to hot contact for 60 seconds at 300^{0}C
- Cold insulation

OUR BOOT FEATURES

All of our boots are approved to either EN ISO 20345 or EN ISO 20347 depending on their application. These icons are used throughout the catalogue to highlight the specific features and benefits of each boot.

EN ISO 20345 and EN ISO 20347 have recently been updated and we are currently in the process of updating the certification of our boots to the 2024 version of these standards; however currently the majority of our products are still certified to the previous 2011/2012 versions. The number of boots certified to the 2024 standard is constantly growing, so for the latest information on certification please check the respirex.com website.

SB Category Safety Boot

Complies with the requirements for safety footwear in EN ISO 20345.

OB Category Occupational Footwear

Complies with the requirements for occupational footwear in EN ISO 20347

Live Working

Dielectric boots that comply with the EN50321 standard for electrically insulating footwear.

Boot Marking: Double Triangle

Toecap

Protective toecap fitted tested for 200J impact resistance and 15kN compression resistance.

Toecap and Mid-sole

Protective toecap fitted tested for 200J impact resistance and 15kN compression resistance. Penetration resistant mid-sole fitted with penetration resistance greater than or equal to 1100N.

Boot Marking: P, PL or PS (see Mid-sole Types below)

Fuel and Oil Resistant

The outer sole is resistant to oil, ensuring the working life of the boot won't be compromised if used in oily environments. The test involves immersion in oil for 22 hours after which the sole is checked for excessive swelling, shrinkage or increased hardness.

Boot Marking: FO

Slip Resistant SR

Tested and approved for resistance to slip on a ceramic tile floor coated with glycerol oil. This is the new enhanced slip performance category of the 2024 standard and the test measures backward slip on the ball of the foot with the heel raised and forward heel slip at a 7° angle (see page 20).

Boot Marking: SR (2024 Standard)

Slip Resistant SRA

Tested and approved for resistance to slip on a ceramic tile floor coated with a dilute soap solution of sodium lauryl sulphate (NaLS). The test measures forward slip on the heel and with the boot flat to the floor. This is now a mandatory test in the 2024 standard.

Boot Marking: SRA (2011 Standard)

Slip Resistant SRC

Tested and approved for resistance to slip on a ceramic tile floor coated with a dilute soap solution of sodium lauryl sulphate (NaLS) and oil (Glycerol) on a steel plate. The test measures forward slip on the heel and with the boot flat to the floor.

Boot Marking: SRC (2011 Standard)

Energy Absorbing Heel

Provides a minimum of 20J cushioning at the heel, reducing the risk of fatigue and injury to joints and spine.

Boot Marking: E

Ladder Grip

Additional cleats added to the instep of the footwear to improve grip on the rungs of a ladder.

Boot Marking: LG (2024 Standard)

Hot Contact

The sole has been tested for contact with a hot metal surface at 300°C for 60 seconds.

Boot Marking: HRO

Cold Insulation

The thermal insulation properties of the boot ensure that the temperature decrease inside a boot at 23°C when placed in a cold chamber at -17°C is less than 10°C after 30 minutes when measured at the upper surface of the insole.

Boot Marking: CI

Mid-sole Types

Metallic mid-soles marked **P** are tested with a 3 mm diameter pyramidal nail and the insert must not be pierced or deformed at 1100 N. S5 category safety boots fitted with a P metallic midsole are marked **S5**.

Composite mid-soles marked **PL** are tested with a 4.5 mm diameter conical nail and the insert must not be pierced or deformed at 1100 N. S5 category safety boots fitted with a PL composite midsole are marked **S5L**.

Composite mid-soles marked **PS** are tested with a 3 mm diameter conical nail and must have an average Penetration resistance of >1100 N and no individual result below 950 N. S5 category safety boots fitted with a PL composite midsole are marked **S5S**.

CLASS 3

26.5kV
Maximum Working Voltage

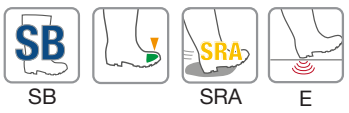
30kV
Test Voltage

DIELECTRIC HV3 BOOTS

An electrically insulating Class 3 dielectric boot with an integral steel toe cap. The Respirex™ Dielectric HV3 boot allows high voltage live working at up to 26.5kV with every boot tested at 30kV.

- Injection molded using our proprietary HV3 compound for a seamless boot with superior electrical insulation properties
- Step voltage protection up to 35kV
- Arc flash protection – Meets the requirements of ASTM F2621-2019 at 40Cal/cm²
- 200 Joule epoxy coated steel toe cap
- Lightweight for increased wearer comfort
- Superb low temperature flexibility down to -40°C
- Environmentally friendly PVC and Halogen free construction
- Biodegradable & Phalate free
- Slip resistant molded sole

EN 20345:2011



SB SRA E

Live Working
CLASS 3
EN 50321-1
26.5kV

40
Cal/cm²
ARC FLASH TESTED

DIELECTRIC HV3 MAXI OVERBOOT

An electrically insulating Class 3 dielectric overboot designed to be worn over safety boots or shoes. The Respirex™ Dielectric HV3 Maxi overboot allows high voltage live working at up to 26.5kV with every boot tested at 30kV.

- Injection molded using our proprietary HV3 compound for a seamless boot with superior electrical insulation properties
- Ingenious rear entry design ensures the boot is quick and easy to fit and remove - Ideal for personnel who have to continually enter and exit hazardous areas
- Single piece injection molded construction with integral molded fastener ensures there are no seams or mounting/fastener holes to leak
- Lightweight for increased wearer comfort
- Environmentally friendly PVC and Halogen free construction
- Biodegradable & Phalate free
- Kick-off lug

EN 20347:2012

OB SRC I

Live Working
CLASS 3
EN 50321-1
26.5kV

For use with safety boots

OVERBOOT STYLES

COMPACT OVERBOOTS

- Designed for safety shoes/trainers
- Opens and fastens at the front
- Molded high-grip sole (SRC)
- Fuel & oil resistant sole (FO)

MAXI OVERBOOTS

- Designed for safety boots
- Opens at the rear, fastens at the front
- Molded sole (HV3) or vulcanized rubber sole (Dielectric)
- Fuel & oil resistant sole (FO)
- Sole resistant to hot contact - 300°C for 60 seconds (HRO)

CLASS 2

17kV
Maximum Working Voltage

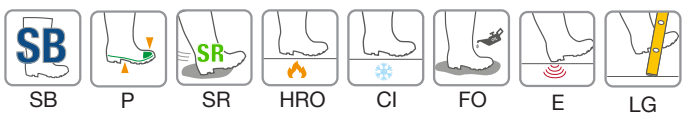
20kV
Test Voltage

DIELECTRIC PRO BOOTS

An electrically insulating Class 2 dielectric boot with an integral steel toe cap and penetration resistant mid-sole, combined with a vulcanized rubber sole for superior slip resistance. The Respirex Dielectric boot allows high-voltage live working at up to 17kV, with every boot tested at 20kV AC, with optional DC testing at 40kV (Class 1).

- The first Class 2 Dielectric boot with an integral penetration resistant mid-sole that continues to provide Class 2 protection even when the rubber outsole is punctured (by a screw/nail etc)
- Injection molded using our proprietary Dielectric compound for a seamless boot with excellent electrical insulation properties
- Step voltage protection up to 35kV
- Arc flash protection – Meets the requirements of ASTM F2621-2019 at 40Cal/cm²
- 200 Joule epoxy coated steel toe cap
- Vulcanized rubber sole for improved slip resistance - 30% better than a conventional safety boot sole
- Durable, cut-resistant vulcanized rubber sole, significantly extends working life, even in harsh terrain
- Cleated outsole for maximum grip in wet and oily conditions (SR)
- Ergonomic cushioned insole (removable & machine washable) for greater wearer comfort

EN 20345:2022+A1:2024



Live Working
CLASS 2
EN 50321-1
17 kV

40
Cal/cm²
ARC FLASH TESTED

DIELECTRIC BOOTS

An electrically insulating Class 2 dielectric boot with an integral steel toe-cap and vulcanized rubber sole for superior slip resistance. The Respirex Dielectric boot allows high-voltage live working at up to 17kV, with every boot tested at 20kV AC, with optional DC testing at 40kV (Class 1).

- Injection molded using our proprietary Dielectric compound for a seamless boot with excellent electrical insulation properties
- Step voltage protection up to 35kV*
- Arc flash protection – Meets the requirements of ASTM F2621-2019 at 40Cal/cm²
- 200 Joule epoxy coated steel toe cap (composite toe-cap and soft toe versions also available)
- Vulcanized rubber sole for improved slip resistance - 30% better than a conventional safety boot sole
- Durable, cut-resistant vulcanized rubber sole, significantly extends working life, even in harsh terrain
- Cleated outsole for maximum grip in wet and oily conditions (SR)
- Ergonomic cushioned insole (removable & machine washable) for greater wearer comfort

EN 20345:2022

SB SR HRO CI FO E LG

Live Working
CLASS 2
EN 50321-1
17 kV

Step Voltage
35kV

40
Cal/cm²
ARC FLASH TESTED

DIELECTRIC COMPACT OVERBOOT

An electrically insulating Class 2 dielectric overboot approved to current European standards, The Compact Dielectric overboot allows high-voltage live working at up to 17kV, with every boot tested at 20kV.

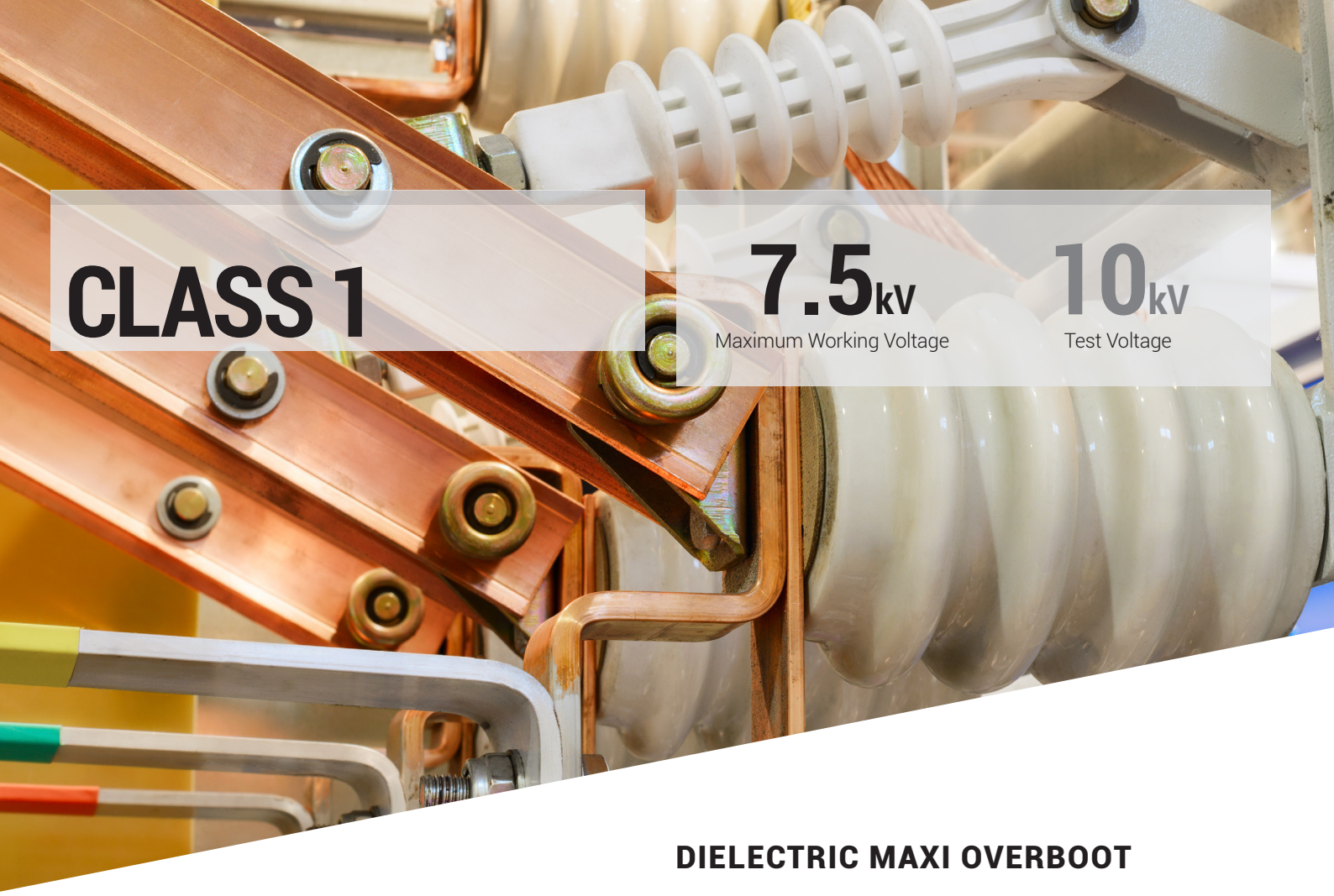
- Injection molded using our proprietary Dielectric compound for a seamless boot with excellent electrical insulation properties
- Easy to use front opening & fastening overboot - ideal for personnel who have to continually enter and exit hazardous areas
- Single piece injection molded construction with integral molded fastener ensures there are no seams or mounting/fastener holes to leak
- No metal fasteners or components used in the construction
- Slip resistant, molded sole (SR)

For use with safety shoes/trainers

EN 20347:2022+A1:2024

OB SR I FO

Live Working
CLASS 2
EN 50321-1
17 kV



CLASS 1

7.5kV
Maximum Working Voltage

10kV
Test Voltage

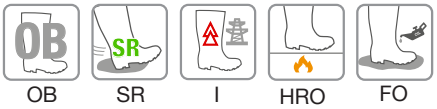
DIELECTRIC MAXI OVERBOOT

A Class 1 electrically insulating dielectric overboot with a vulcanized rubber sole for superior slip resistance. The Respirex™ Maxi Dielectric overboot is designed to be worn over safety boots and allows live working at up to 7.5kV with every boot tested at 20kV for ASTM F1117.

For use with safety boots

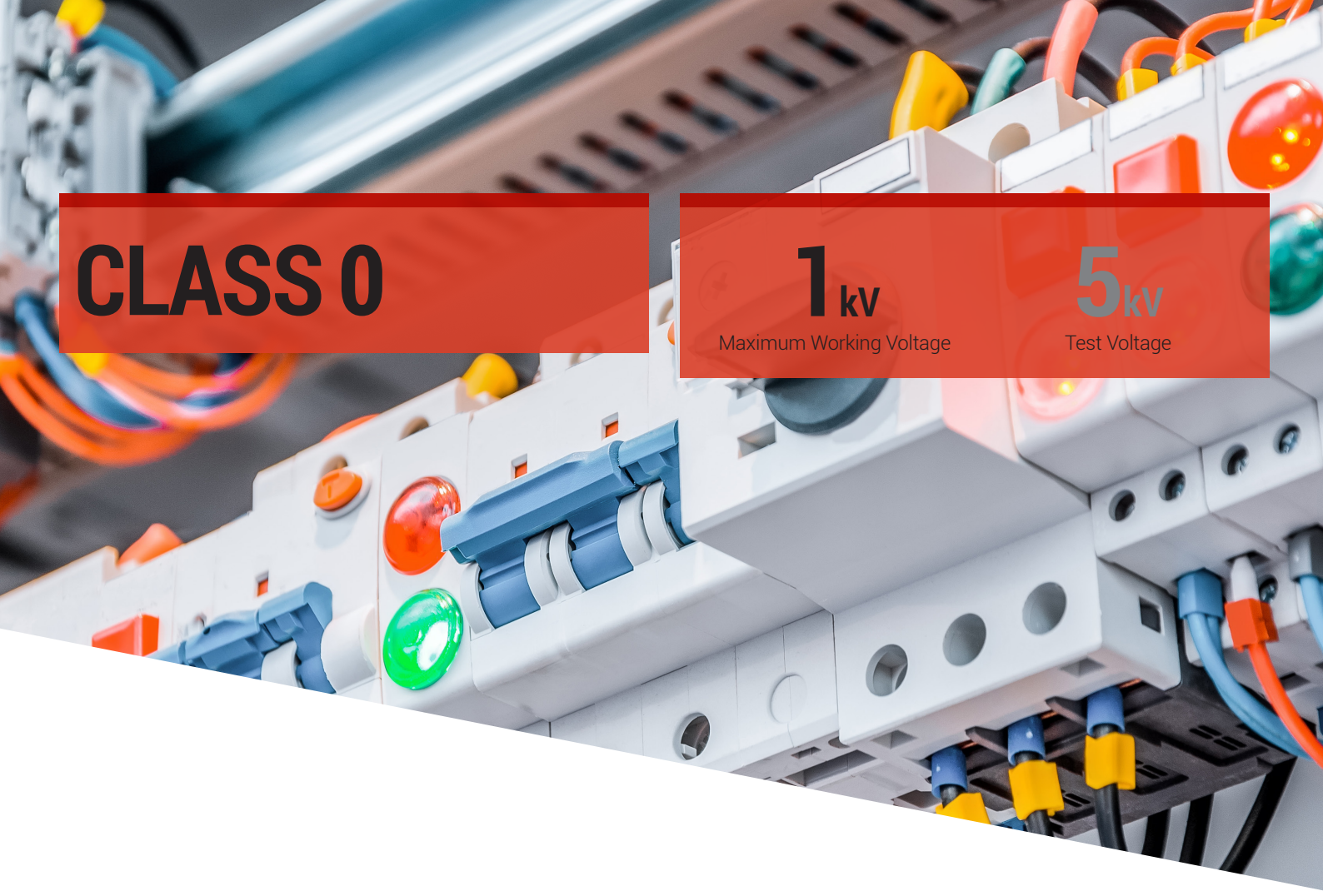
- Injection molded using our proprietary Dielectric compound for a seamless boot with excellent electrical insulation properties
- Ingenious rear entry design ensures the boot is quick and easy to fit and remove - ideal for personnel who have to continually enter and exit hazardous areas
- Single piece injection molded construction with integral molded fastener ensures there are no seams or mounting/fastener holes to leak
- Vulcanized rubber sole for greatly improved slip resistance in wet and oily conditions (SR)
- Durable, cut-resistant vulcanized rubber sole, significantly extends working life, even in harsh terrain
- Fuel and oil resistant sole

EN 20347:2022+A1:2024



OB SR I HRO FO

Live Working
CLASS 1
EN 50321-1
7.5kV



CLASS 0

1 kV
Maximum Working Voltage

5 kV
Test Voltage

DIELECTRIC N BOOT

A Class 0 electrically insulating dielectric boot with an integral steel toe cap and Nitrile/PVC sole. The Respirex™ Dielectric N boot allows high-voltage live working at up to 1kV, with every boot tested at 5kV.

- Injection molded using our proprietary Dielectric compound for a seamless boot with excellent electrical insulation properties
- 200 Joule epoxy coated steel toe cap (soft toe version also available)
- Slip resistant molded sole
- Cleated outsole for maximum grip
- Moisture absorbing insole (removable and machine washable)
- Energy absorbing tunnel system in heel to EN 20345:2011 E

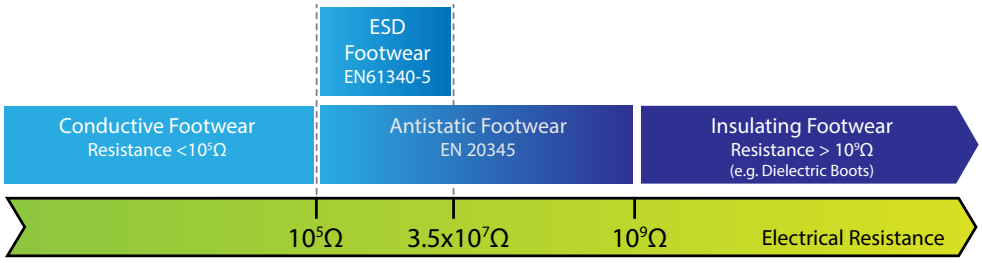
EN 20345:2011

SB SRA E FO

Live Working
CLASS 0
EN 50321-1
1kV

INSULATING, ANTISTATIC AND ESD FOOTWEAR

According to EN 20345: 2011, a shoe or boot is considered to be **antistatic** if its' measured electrical contact resistance falls between **100 kΩ** (10^5 ohms) and **1 GΩ** (10^9 ohms). With a lower resistance, a shoe or boot is considered to be conductive and at higher values, to be **insulating**. This 100kΩ to 1GΩ range is regarded a sensible compromise for general safety footwear, giving protection from electrostatic build up and protection from electrical shocks at lower voltages. For **Electro-Static Discharge (ESD)** footwear, which us used in potentially explosive atmospheres and in the production of sensitive electronic components and devices, the lower limit of electrical resistance is **100 kΩ** (the same as for antistatic footwear) and the upper limit is **35 MΩ** (3.5 x 10^7 ohms).



HEAT & FLAME RESISTANCE

Boots that are resistant to heat and flame for use in areas where there is a risk of sparks from welding or grinding or in proximity to heat and flame. Heat resistant safety boots conform to the EN15090 F3A I_3 fire boot standard for flame resistance, radiant heat (20 kW/m^2) and heat insulation of the sole (250°C for 40 minutes).

COMFORT INSOLES

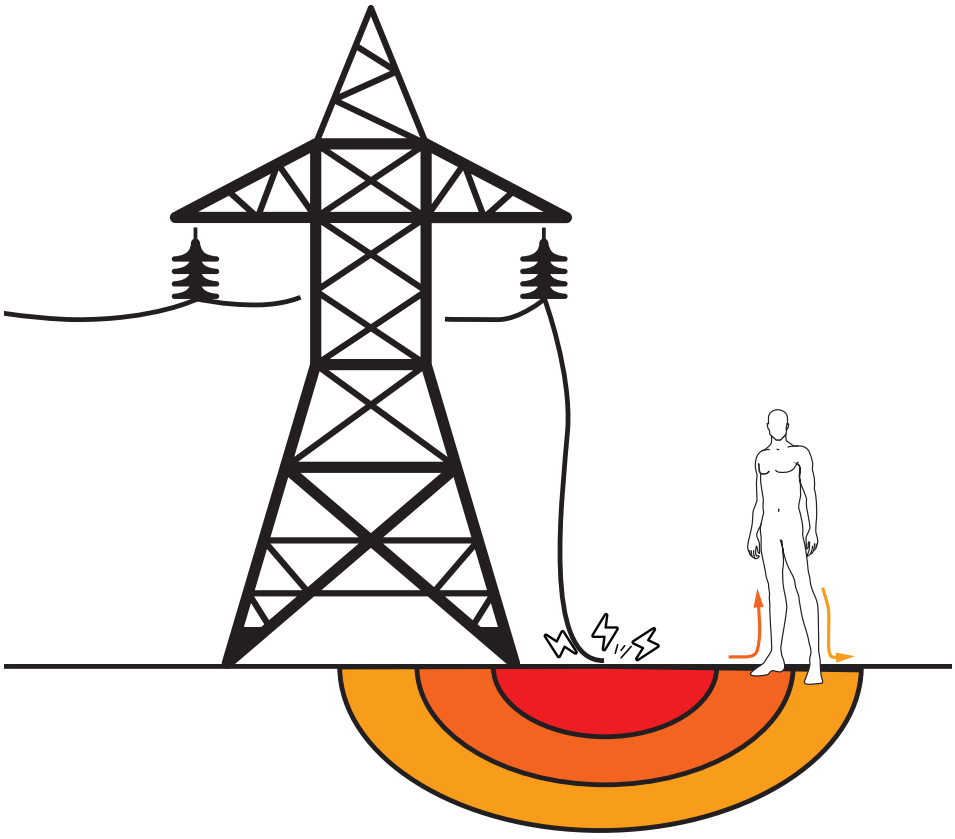
Our latest ergonomic design comfort insoles went through an extensive wearer trails program and the results demonstrated a significant improvement in cushioning and wearer comfort. Thermal insulation has also been greatly improved, with a temperature drop of only 0.5°C in the EN 20345 cold insulation test, an improvement of 90% over our previous insole.

Comfort insoles are fitted as standard to all of our boots except the Hazmax YS, Dielectric N, Solestar and Digger models, where they are available as an option. Replacement insoles are also available.

STEP VOLTAGE HAZARDS

Step voltage is the voltage between the feet of a person standing near an energized grounded object during an electrical fault, such as a power line short circuit or even a lightning strike. In this situation electric current flows through the surrounding soil and the resistivity of the soil creates a potential gradient that is at its highest at the fault and decreases as you get further away. If a persons feet are different distances from the fault, the difference in electrical potential (voltage) between them can pose a significant risk, as current can pass through their body from one foot to the other. The primary danger associated with step voltage is the potential for severe electric shock, which can lead to serious injury or even death. Understanding and mitigating the risks of step voltage is crucial for ensuring safety in areas prone to electrical faults, such as pylons, substations and high voltage industrial environments.

Although step voltage passes through a persons legs and groin, avoiding vital organs, when a person is subjected to a high step voltage, their muscles will contract, potentially causing them to fall to the ground. This not only increases the current acting on the body, but also changes the path of the current, potentially causing it to flow across the heart or through the head; this type of electric shock can be fatal.



RESPIREX™

FIND OUT MORE

For more details on our range of specialist protective footwear visit our website:

www.respirex.com

Rev B 2025