Antistatic protective clothing – requirements and test methods

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Introduction

Use of antistatic protective clothing is required in potentially explosive areas and outside the hazard zones, among others in the production of electronic components in order to protect them from destruction as a result of an electrostatic discharge (ESD). This paper is addressed mainly to the OHS personnel in the plants, who are responsible for selection of protective clothing in workplace. The main condition for such a selection is identification and risk assessment that allows to determine required protective parameters of clothing.

One of the basic components of employee protection is protective clothing. Charge generation on used clothing can dangerously generate charge on human body, which in turn may cause fire, explosion or accidents. At the workplaces where explosive atmosphere may occur (explosion hazard zones within the meaning of the Regulation of the Minister of Economy of 8th July 2010 on the minimum requirements regarding occupational health and safety, related to the possibility of occurrence of explosive atmosphere at the workplace – Journal of Laws of 2010, No. 138, item 931) protective clothing made of materials with good anti-electrostatic properties confirmed by the tests in specialized laboratories shall be used. Antistatic clothing is also required outside explosion hazard zones, where electrostatic protection is used for other reasons, e.g. in electronic industry, in manufacturing and assembly of static-sensitive components, as well as while operating electronic measurement instruments, computers, etc.

Protective clothing includes: clothes, footwear, gloves and headgear. When choosing the clothing protecting against static electricity, apart from basic occupational health and safety requirements, one has to also consider requirements regarding electrostatic protection. This means that protective clothing used for example in explosion hazard zones cannot undergo electrostatic charge generation or generate charge on worker body, as electrostatic discharges (ESD) from human body or part of protective clothing can result in fire and/or explosion.

Electrostatic protection requirements applying to protective clothing

Antistatic protective clothing must meet specific requirements specified in normative documents. Some of this requirements are described below.

- According to PN-EN 1149–5:2009 [9] the environment, where explosive atmospheres are formed, requires use of protective clothing made of materials with surface resistivity $R_s \leq 2.5 \times 10^8 \, \Omega$, tested in accordance with PN-EN 1149–1:2008 [6] and/or charge decay half-time $t_{90} < 4 \, s$, tested in accordance with PN-EN 1149–3:2007 [8].
- According to PN-EN 1149–5:2009 [9], PN-E-05204:1994 p. 3.3.2 c/ [4] and IEC/TS 60079–32–1:2013 p. 11.5 [2] in potentially explosive zones protective clothing cannot be put on or taken off, it is also forbidden to wear undone clothes. Cleaning clothes within the explosion hazard zone is strictly prohibited. This requirement also applies to other personal protective equipment.
- According to PN-EN 61340–5–1:2009 [13] clothing used in manufacturing, assembly and operation of electrostatic-sensitive electronic devices shall be made of materials with point-to-point resistivity ($R_p$) meeting the condition $R_p < 1 \times 10^{12} \, \Omega$, tested in accordance with IEC 61340–4–9:2013 [12].
- According to PN-E-05204:1994 p. 3.3.2 f, h) [4] employees present in indoor and outdoor areas with established hazard zones 0, 1 and 20, must be equipped with conductive footwear of soles volume resistivity $R_s \leq 1 \times 10^6 \, \Omega$. In the presence of media with minimum ignition energy MIE $\leq 0.1 \, mJ$, footwear with soles $R_s = 1 \times 10^6 \, \Omega$ shall be used regardless of determined hazard zone.
- According to PN-E-05204:1994 p. 3.3.2 j/ [4] in indoor areas with explosion hazard zones 2, 21 and 22 in the presence of media of MIE $> 0.1 \, mJ$, allowable human body leakage resistance $R_{hl} = 1 \times 10^{10} \, \Omega$.
- According to IEC/TS 60079–32–1:2013 p. 11.3 [2] satisfactory protection against generation of dangerous electrostatic discharges from human body in explosive atmosphere is provided by wearing footwear of soles volume resistivity $R_s$ below 100 M$\Omega$, when appropriate conductive floor is used at the same time.
- According to IEC/TS 60079–32–1:2013 p. 11.3 [2] in indoor areas where explosive materials are handled, footwear with soles volume resistivity $R_s < 1 \times 10^8 \, \Omega$ shall be used; according to PN-E-05205:1997 [5] human body leakage resistance, being a total of $R_{hl}$ and footwear $R_s$, cannot exceed 1 M$\Omega$.
- According to PN-EN 16350:2014 [15] in explosion hazard zone protective gloves shall be used that “dissipate electric charge” made of material with volume resistance $R_v < 1 \times 10^9 \, \Omega$, determined in accordance with PN-EN 1149–2:1998 [7].
- According to IEC/TS 60079–32–1:2013 p.11.3 [2] and p. 1.6 in areas with explosive atmospheres allowable is human body leakage resistance ($R_{hl}$) through protective footwear or gloves up to value of 100 M$\Omega$ in case if given personal protective equipment is intended to “ground” human body.

Protective clothing test methods

The normative documents specify both requirements and test methods for finished products and materials used for antistatic protective clothing. For example, test methods of resistance of clothing used under explosive atmosphere are defined in Polish Standards:

  Part 1: Test method for measurement of surface resistivity.
  Part 2: Test method for measurement of volume resistivity.

- PN-EN ISO 20344:2004 Personal protective equipment. Test methods for footwear

All the aforementioned test methods for protective clothing shall be conducted in accredited research laboratories.

Summary

Antistatic protective clothing is a product generally available on the market. However, it must be noted that the term “anti-electrostatic (antistatic) properties”, used for advertising product for marketing purposes, often has nothing to do with reliable information on given product properties. Saying that product is antistatic is not the same as possibility of using it safely, e.g. in the presence of explosive atmosphere. Thus, when choosing clothing protecting against static electricity effects the special attention shall be paid to protection criteria. For example, “antistatic dissipative” footwear with soles resistance meeting requirement $1 \times 10^8 \leq R_s < 1 \times 10^8 \Omega$ (acc. to PN-EN 61340–5–1:2009 [13]) will be suitable for use in electronic industry, where protection of electronic components and assemblies susceptible to electrostatic discharges which may cause their destruction (ESD protection). While the same footwear will not provide sufficient protection e.g. when handling explosive materials (e.g. acc. to IEC/TS 60079–32–1:2013 [2] footwear soles resistance meeting requirement $R_s \leq 1 \times 10^8 \Omega$ is required).

Tests of antistatic properties of protective clothing are among others conducted at the accredited Laboratory of Dangerous Properties of Materials of the Institute of Industrial Organic Chemistry in Warsaw (Accreditation Certification PCA No. 374), which has years of experience in this field.

Literature

10. PN-EN 61340–2–3:2002 Electrostatics. Part 2–3: Methods for test determining the resistance and resistivity of solid planar materials used to avoid electrostatic charge accumulation.
16. Regulation of the Minister of Economy of 8th July 2010 on the minimum requirements regarding occupational health and safety, related to the possibility of occurrence of explosive atmosphere at the workplace (Journal of Laws, No. 138, item 931).

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