Understanding Anti-Static in Limited Life Coveralls

Lakeland
Protect Your People™

Disposable coveralls are commonly marked with the anti-static pictogram to indicate that the garment is 'anti-static'. But what does this actually mean? Does it guarantee the garment meets the specific requirements of your application?

What does 'anti-static' mean?

Static is electricity that builds on surfaces as a natural consequence of movement and friction. Synthetic materials, such as the thermoplastics commonly used to make disposable clothing, are particularly disposed to this. Fabric will develop a static charge which will always try to move towards an opposite charge such as the earth and will seek the quickest route to get there. In some cases, should the charge build sufficiently, it will 'jump' across a space to an oppositely charged surface in the form of a spark.

If this happens in an environment with flammable fumes, vapours or dust, it could ignite the explosive atmosphere. The purpose of 'anti-static' clothing is to avoid – or at least reduce the probability – of this happening.

What does 'anti-static to EN 1149' mean?

EN 1149-5

EN 1149 is the CE standard that defines and classifies anti-static clothing. It consists of 5 parts. The first three of these are test standards to measure anti-static properties. Part 5 details garment requirements, so clothing is certified to EN 1149-5, having been tested to at least one of the other parts.

Part 5 states that protective clothing should meet requirements measured either in:

- **Part 1** (Surface Resistance – the tendency to allow a charge to dissipate across its surface)
  or
- **Part 3** (Charge Decay - the tendency to allow a charge to decay from a point on it's surface)

The majority of single-use protective clothing is tested according to Part 1: Surface Resistance. [*1]

The requirements if tested to Part 1 are that the fabric should have a maximum surface resistance of 2.5×10^9 Ohms ('Ohms' being a measurement of electrical resistance) when tested after being pre-conditioned for 24 hrs at a temperature of 23(+/- 1)°C and a relative humidity of 25(+/-5)%.

So the anti-static pictogram on a garment tells you only that one sample of the fabric, on one occasion, under laboratory test conditions and with the specified pre-conditioning, showed a surface resistance of less than 2.5×10^9 Ohms. It tells you nothing more and nothing less.

Why is the requirement set at a maximum of 2.5×10^9 ohms?

This is a very good question; why is this level of surface resistance the 'cut-off' point? It suggests that a surface resistance above this will result in an incendiary spark, and one below this will not.

There is some uncertainty over the origin of this figure. However, given the variety of circumstances and environments that might occur, it seems unlikely that the dividing line between 'spark or no spark' could be as clear or simple as this. More likely this is a question of probabilities; at some point it has been determined that this is a suitable cut-off point that reduces the likelihood of a static spark sufficiently for most normal circumstances. [*2]

How is this achieved?

The property of a material to conduct electricity (i.e. allow it to travel through or across it) is its 'conductivity'. The opposite (i.e. its tendency to RESIST) is its 'resistance' or 'resistivity'. The purpose of clothing being 'anti-static' is to reduce its resistance so that any electrical charge that develops can dissipate through or across the material and to earth harmlessly, without jumping to another surface and without an incendiary spark.

In woven fabrics the usual method is to include threads of a conductive fibre such as carbon in the weave. Any charge then readily travels along this conductive fibre. This can normally be seen as a dark coloured grid in such fabrics. However this would be too difficult and/or costly to do in disposable nonwoven fabrics and films so a different method has been developed.

Water is highly conductive. Thus a chemical treatment that is moisture absorbent is applied to the whole surface of the fabric at the manufacturing stage. When the garment is in use this absorbs moisture from the atmosphere, holding a thin film on the surface. This film is conductive and so allows a charge to readily 'dissipate' and, provided it has a route, go to earth harmlessly.

Why the pre-conditioning?

The requirement for pre-conditioning of the fabric at a relative humidity of 25% is important. 25% is a very low humidity – unusually low – that only rarely occurs naturally. In the majority of locations globally, humidity is likely to be in excess of 50% and probably closer to 100%. Given that the anti-static treatment relies on absorbing moisture from the atmosphere, the implication is that in most cases the treatment will be much more effective than in the test (because in most cases more moisture is available) so surface resistance will be much lower than indicated by the test. In other words, there is a wide safety margin built into the standard.

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What does this mean in the real world? What practical steps can be taken to better manage anti-static and explosive atmosphere risks?

Three issues are critical in assessing the consequences for users of chemical suit that are 'anti-static':-

a. Garment 'anti-static' relies on surface resistance and allowing a charge to go to earth harmlessly

However, in order for it to 'go to earth' it needs a route to get there and users must consider how this is ensured:-

i. One of the best routes is through the human body (we are mostly made of water) but this relies on the surface of the coverall being constantly in contact with the wearer's skin – perhaps at the wrists or ankle.
ii. It also relies on the assumption that neither the wearer's footwear nor the floor is insulating; either would prevent the charge going anywhere.
iii. Alternatively, choose a garment with attached socks which, when worn over the wearers normal footwear will ensure the fabric remains in constant contact with the floor (again, assuming the floor is not insulated!)
iv. Finally, if feasible, in some cases it may be appropriate to maintain a conducting cable with one end clipped to the coverall and the other to a known grounding point.

b. The required level of anti-static of a fabric (i.e. its surface resistance) is achieved through a topical treatment on the fabric surface

The topical treatment is essentially a weak surfactant or detergent that is moisture absorbent. However, any topical treatment will fade, wear or rub off over time. So if anti-static properties are critical, management of the process and use might be important:-

i. Limit the time that coveralls are used. If use time is long, consider more regular changing to a new suit, especially if the application involves higher than normal abrasion of the suit or rubbing on other surfaces.
ii. Avoid continuing use of damaged suits; leaving aside the fact that a damaged suit is not protecting the wearer, an electrical charge cannot jump across a tear.
iii. Do not re-use suits and definitely never wash and re-use them. Washing will remove the anti-static treatment.
iv. There is little known evidence of how long anti-static treatments last on stored coveralls. However, good practice would suggest avoiding use of older coveralls on which the treatment may have faded, and choose garments packed in sealed bags rather than ones that merely have tape at the bag opening. Also do not un-pack garments until they are to be worn.

c. The EN 1149-1 test is conducted under laboratory conditions generally more stringent than the real world

The fact that fabric is pre-conditioned at a relative humidity of 25% means that generally garments will actually be used in humidity's much higher than this. So in most cases the surface resistance will be lower (i.e. the anti-static properties 'better') than indicated by the test. However, if anti-static is critical in an application there are practical steps that users can take to minimise risk:-

i. Consider monitoring humidity in the work area. Clearly if humidity is very low the risk is higher so avoidance of particular tasks might be appropriate where possible
ii. If possible, in indoor work areas, during dry spells or in dry areas, consider using humidifiers to ensure the humidity is maintained at a high level. This ensures the anti-static treatment has more moisture available to work more effectively.

Finally… Don't use Standard Disposables!!!

In areas where explosion is a high risk, and given the uncertain nature of anti-static properties of disposable coveralls, the wise choice might be to not use this type of standard coveralls but to choose a more specialist option:-

i. Pyrolon™ coveralls offer protection through Types 3 to 6, are flame retardant to EN 14116 (Index 1) AND because of the unique fabric construction, have intrinsic anti-static properties and generally low Surface Resistance.
ii. In extreme cases consider using specialist anti-static clothing that uses woven fabric with carbon fibre thread to maintain high conductivity and low resistance.

Conclusion

Anti-static properties and requirements of disposable coveralls is a confusing and difficult area. Perhaps more than most areas of PPE this is a case of minimising risk rather than guaranteeing protection. However, with greater understanding there are practical steps that can be taken in the selection and use of garments along with the management of the task and work area, that ensure risk is kept to a minimum.

Notes

*1 Part 2 is a test to measure 'vertical resistance' – the tendency to allow a charge to pass THROUGH the fabric. Part 4 is intended to be a test method for whole garments but this has not been successfully established at the time of publication.

*2 It is notable that several other local standards, such as the UK DSEAR regulation (derived from the European ATEX directives) and the German standard BGR 132 relating to equipment for use in explosive atmospheres, whilst not specifically relating to protective clothing both indicate that EN 1149-5 is the best indicator of garment suitability. In the case of BGR 132 it also defines a surface resistance that is less stringent than EN 1149-5. In addition the US has a similar test method, but the preconditioning is done at a relative humidity of 50%, making it 'easier' to achieve a pass. This suggests that EN 1149-5 is the most stringent and 'best' assessment in use.