DUPONT™ Tyvek®

E-Guide - Solid Particles

RAISING DUST - HOW TO PROTECT EMPLOYEES FROM SOLID PARTICLE HAZARDS

THIS E-GUIDE IS CLICKABLE

Foreword

Risks associated with exposure to solid particles can be widespread across industries and sometimes invisible to the naked eye. The exposure mechanisms and sheer variety of hazardous solid particles make the selection of appropriate personal protective equipment (PPE) a key factor in mitigating risk.

This e-guide offers support to HSQE managers in the understanding and assessment of solid particle risks and guidance about the selection of protective garments for workers. It includes a summary of relevant legislation and guidelines, main contamination risks, and how the latest garment solutions can help address them. The concluding section offers best practice advice to encourage a more holistic approach to improving employee safety by raising awareness of solid particle hazards.

Content overview

1/ Introducing solid particle hazards

Solid particles in industrial and manufacturing environments present a unique set of hazards for employees and a unique set of challenges for health and safety professionals. They are commonly referred to as 'dust,' but what does this term mean?

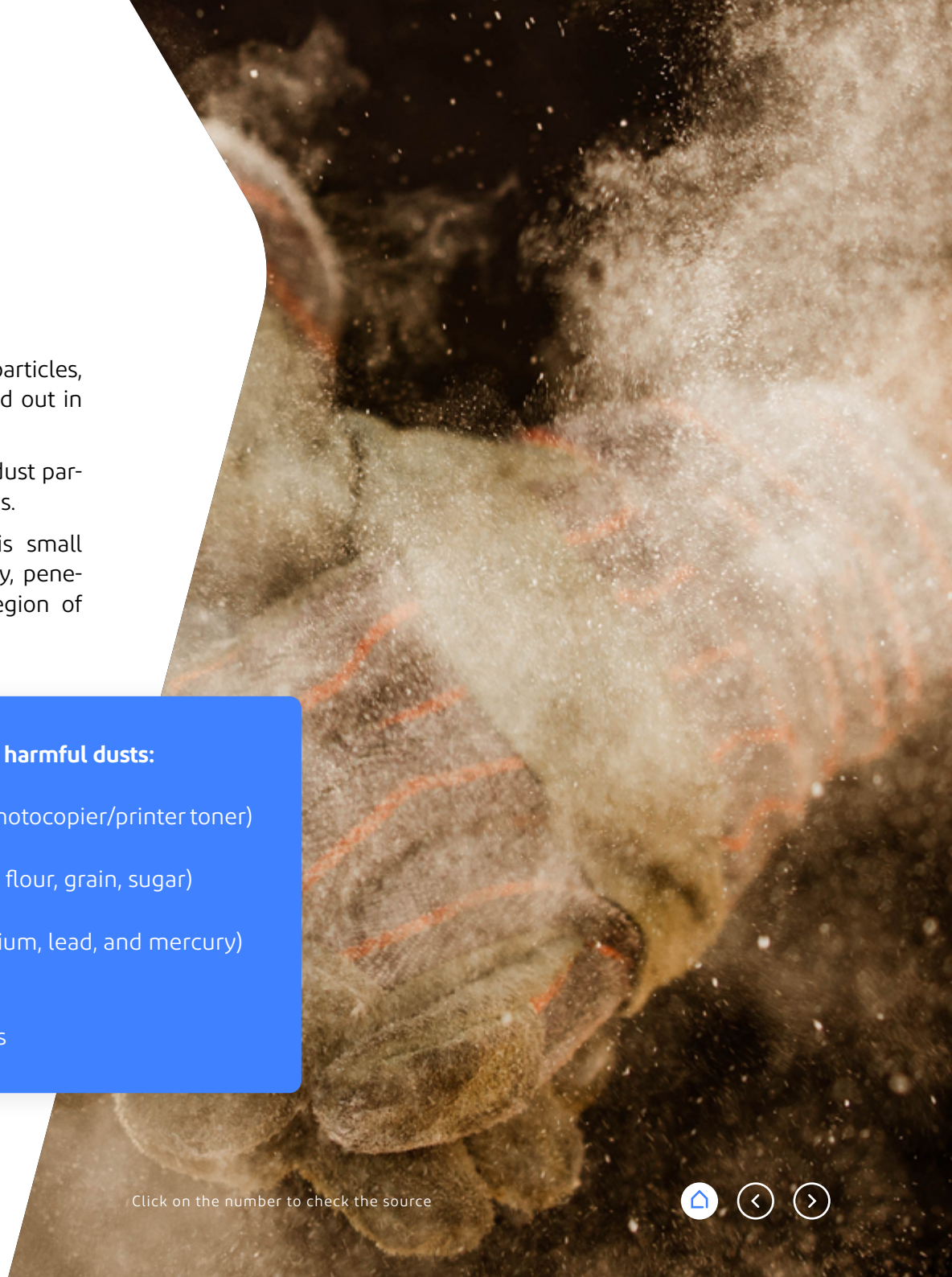
DUST – A DEFINITION

Dust is usually defined as a solid which has been broken down into powder or fine particles[1]. Modern workers may be exposed to a whole range of dusts, including, PCB dust, mineral and chemical particles, and powder coatings (see box-out). These dusts can be carcinogenic, toxic, and/or irritating to the skin and lungs. From an occupational health perspective, dust is classified by its likely effect on the body:

- inhalable dust: larger-sized particles, most of which will be filtered out in the nose and throat.
- thoracic dust: smaller-sized dust particles that can reach the lungs.
- respirable dust: dust that is small enough to be inhaled deeply, penetrating the gas-exchange region of the lungs.

Common sources of harmful dusts:

- Carbon black (i.e. photocopier/printer toner)
- Cement
- Dry foodstuffs (e.g. flour, grain, sugar)
- Exhaust fumes
- Metals (e.g. chromium, lead, and mercury)
- Minerals
- Nanomaterials
- Paints and coatings



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1/ Introducing solid particle hazards

Size matters

Generally, the most hazardous dust types are those with very small particles which are invisible to the human eye. Not only are these particles small enough to pass unseen, but they can also travel deep into the lungs if inhaled. The human eye can detect particles of 50 microns and above but some dust particles are smaller than this. However, there are exceptions: substances like asbestos produce larger, visible particles which are also hazardous because they do not break down easily in the body. In environments where larger particles are observed smaller, invisible particles may also be present[2].

The rise in the use of nanomaterials in various industrial processes should be noted. Nanomaterials are defined as having at least one external dimension that measures 100 nanometres or less or with internal structures measuring 100 nm or less. Essentially, nanomaterials may have the same composition as known materials in bulk form but may behave differently if they enter the body. They are rapidly finding applications in cosmetics, electronics, healthcare, information technology, and environmental protection. For example, nanosilver is used in a range of products, including washing machines, socks, food packaging, wound dressings, and even food supplements[3].

Means of transmission

Solid particles can be transmitted through various mechanisms, including being suspended in the air in aerosol form, which makes them easy to breathe in. If they pass into the lungs, they can accumulate over time. The quantities being inhaled will depend upon multiple factors but include particle concentration and the ease and the ease and frequency of airflow into the lungs[4].

Particles can also accumulate readily on surfaces due to gravity. Workers come into direct contact by touching or brushing against these contaminated surfaces. Larger particles may wash off, but even short periods of contact may cause irritation depending on the substance. Smaller particles can even pass through the skin and enter the bloodstream to accumulate in the body[5].

Health implications

The consequences of exposure to hazardous solid particles vary depending on the industry, occupation, and specific substances involved, but they can include anything from skin irritation and allergies to long-term respiratory disease, cancers, and even death.

According to the Health & Safety Executive (HSE), around 12,000 people die in the UK each year due to workplace respiratory diseases. Chronic Obstructive Pulmonary Disease (COPD) is the largest single killer, accounting for 34% of fatalities[6]. However, statistics on the exact number of affected individuals in Europe are not readily available. The EU-OSHA Workers' Exposure Survey (WES) on cancer risk factors in Europe seeks to address this lack of data. Initial findings suggest that there is increased risk for workers in micro or small-sized workplaces compared to medium-sized or large workplaces and for those working over 50 hours a week[7].

Whatever the size of your company or the scale of the risk, choosing the correct type of PPE plays an essential role in reducing exposure to solid particles and the health issues they can cause.

2/ Challenges for HSQE managers

The often-invisible nature of solid particle hazards and their highly variable nature raise specific challenges for HSQE managers, including:

Identifying complex hazards:

Solid particle hazards vary widely in composition, size, and sources. Identifying all potential sources and understanding their impact on health and safety can be complicated.

Characterising risk:

Assessing health risks associated with specific particle types requires knowledge of toxicology and epidemiology, which can make the assessment of individual risk and cumulative effects problematic.

Quantifying exposure levels:

Measuring airborne particle concentrations accurately requires specialized equipment and expertise. Variability in exposure over time and across different tasks adds to the complexity.

Understanding protective clothing choices:

Normal protective overalls do not provide an acceptable barrier to hazardous solid particles. It is therefore essential for HSQE managers to familiarize themselves with the specific barrier properties required (see section 4).

3/ Regulatory Guidance

Regulation (EU) 2016/425 on PPE governs the design, manufacture, and sale of PPE within the EU. It states that Cat III Type 5 protective clothing must be used to protect workers from solid airborne particulates.

Category III Type 5 chemical protective coveralls offer full-body protection, covering the trunk, arms, and legs. They must meet EN ISO 13982-1 standards to ensure effective protection against solid particles. A key test for Type 5 garments is the penetration cabin test, which assesses the ability of PPE to act as an effective barrier to solid particles. This test is designed to simulate real-world conditions where PPE, including protective clothing, masks, or gloves, might be exposed to dust particles. The goal is to assess how well the PPE can prevent dust from penetrating through the material and reaching the wearer.

Dust particles of a specific size and concentration are generated within a test cabin (or dust chamber) to create a consistent and measurable dust cloud. A test subject, wearing the PPE, carries out predetermined sequence of test exercises. Sensitive instruments are then used to monitor the concentration of dust particles inside the suit at different locations. The amount of dust that has penetrated is calculated to obtain inward leakage rates, and this evidence determines whether the garment receives a pass or fail.

Type 5 chemical protective clothing must achieve inward leakage (IL) ≤30% IL for 91.1% (or more) of all values measured (all exercises, all sampling positions, all garments) and a total inward leakage (TIL) ≤15% for 80% (or more) of all TIL values.

A word of caution

Cat III Type 5 'pass' mark does not mean that the garment is providing total protection from dust ingress. Coveralls are only required to meet the minimum performance requirements specified. The Type 5 test makes an allowance for individual leakages of up to 30%, providing the total inward leakage average for the garments tested is less than 15%[8].

HSQE managers should therefore ask to see the percentage of penetration result when assessing a garment's Type 5 barrier protection qualities.

4/ Garment selection

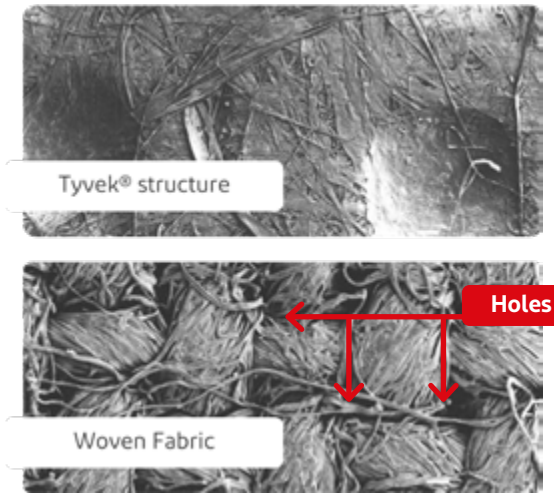
In addition to compliance with regulations, HSQE managers must consider aspects including the barrier properties of the garment material, seams, and closures, as well as wearer comfort (see Garment Checklist). Protective garments should be appropriately designed, durable, and fit the user properly.

Garment checklist:

- High particle barrier (material, seams)
- Smooth surface to prevent particles from adhering to the garment.
- Tight fit at arm and leg openings (elasticated cuffs and ankles)
- Compatible with additional PPE (masks, goggles, gloves)
- Comfortable to wear, high freedom of movement.

Material considerations

Normal workwear made from woven materials is riddled with holes through which solid particles can easily pass. Protecting workers from solid particles therefore requires approved garments that use non-woven materials with special barrier properties. One example is DuPont™ Tyvek®, a non-woven fabric of spun polyethylene fibers that offers superior protection against airborne particles as small as 1-2 µm. The difference between woven material and Tyvek® is illustrated in Figure 1. Offering high abrasion and tear resistance, Tyvek® combines a characteristic smooth surface and antistatic treatment to help prevent particles from adhering to the coverall.



Non-woven material

- consists of spun chemical fibers
- solidified to form textile fabric (mechanically or thermally)

Fabric

- consists of threads
- woven together to form textile fabric (interlaced thread systems)

4/ Garment selection

Better by design

The design of protective garments is another important aspect of preventing solid particle ingress. Seams can be a weak point, due to the holes caused by stitching. Look for garments that have taped seams, which offer added protection from particle penetration. Zippers and fasteners should also have protective flaps. Particular attention should be paid to the interfaces between the main garment and other PPE, such as respirators, gloves, and boots. Any gapping raises the likelihood of the wearer being exposed. Opt for garments that feature integral gloves and boot covers (see Figure 2) or a respirator-fit hood to avoid the usage of adhesive tape to seal off the connection points.

Wearer comfort

Garments that are comfortable to wear encourage workers to adopt safe practices by using appropriate PPE. Look for coveralls that feature a comfort-fit design that aids worker mobility and makes the garments easier to put on and take off. Also, consider whether the fabric is suitably lightweight and soft to prevent chafing. Ideally, it will also be permeable to both air and water vapour, keeping the wearer cool and preventing perspiration build-up.

Figure 2: garments with integral gloves and boot covers eliminate gapping between protective coveralls and accessories.

Consider Tyvek® 600 Plus as the ideal garment protecting against fine particulates as taped seam are tight to dust.

5/ Beyond compliance

Persuading workers that they are at genuine risk and therefore must wear appropriate protective garments can be a challenge for HSQE managers. It is easy to become complacent about a risk you cannot see or a substance that you believe to be benign, like flour dust.

Ensuring workers understand the risks and follow safety protocols is just as important as selecting the right level of protective garment. The value of repeating safety messages and providing appropriate training, particularly around donning and doffing procedures, is considerable.

Reputable PPE manufacturers like DuPont have developed training resources to support HSQE managers in educating their workers about the risks associated with hazardous solid particles and reinforcing best practices in personal protection.

6. Conclusion

Solid hazardous particles present a serious risk to worker health and safety. Although the mechanisms by which solid particles can cause harm are well understood, the scale of the problem across Europe is still being determined. The complex and variable nature of harmful dusts can make risk assessment problematic, and the introduction of new nanomaterials is raising new challenges for HSQE managers.

PPE such as protective clothing is key to preventing contamination, but care must be taken to ensure that the barrier properties of these garments are adequate. Global suppliers like DuPont Personal Protection have developed special materials and garment designs to support HSQE managers in delivering appropriate levels of protection[9].

For more information on DuPont™ Tyvek® solutions for hazardous solid particle protection visit:

tyvek.com/ppe

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