

DuPont Personal Protection

DUPONT™ Tyvek® Forward Together™

# Product catalogue

tyvek.com/ppe

Tyvek | Tychem | ProShield



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# Content overview


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DUPONT Tyvek® Forward Together™

**Forward Together™.**

That simple but powerful statement represents the culmination of the two sides:

**The materials side** - the science, the testing,

**The people side** - the relationships, the collaboration.

From all of us at DuPont™ Tyvek® to all of our customers - the creators, the makers, the carers, the builders, and the protectors - it is our promise to innovate alongside them, share our vast knowledge and expertise, and work together more reliably than anyone else can.

It's what makes our products perform like no other. **It is our truest differentiator.**

It is essential to what we do, who we are, and where we're going.

Which is Forward Together™.

# DuPont Product Range

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## Tychem®

| | | | |
|---|---|---|---|
| Gaseous substances | **Tychem® TK** | Protection against a broad range of toxic, corrosive gases, liquids and chemicals | Cat.III, Type 1a-ET |
| An air-fed suit made for extremes | **Tychem® 6000 AL** | Helps provide maximum protection against various harmful chemicals in liquid, spray, aerosol and mist form as well as solid particles including radioactive particulates | Cat.III, Type 3-B, 4-B, 6-B, EN 1149-5, EN 14126, EN 1073-1, EN 14594 |
| High levels of protection, compatibility with respiratory equipment | **Tychem® 6000 F FaceSeal** | Tight design combined with trusted Tychem® protection | Cat.III, Type 3-B, 4-B, 5-B, 6-B, EN 14126, EN 1073-2, EN 1149-5 |
| Barrier technology | **Tychem® 6000 F Plus** | Tychem® 6000 F barrier in new innovative designs versions with attached gloves and/or dissipative socks | Cat.III, Type 3-B, 4-B, 5-B, 6-B, EN 14126, EN 1073-2, EN 1149-5 |
| Integrated socks with pioneering static charge dissipative sole | **Tychem® 6000 F with dissipative socks** | Earthing made easy through adequate footwear | Cat.III, Type 3-B, 4-B, 5-B, 6-B, EN 14126, EN 1073-2, EN 1149-5 |
| Organic and highly concentrated inorganic chemicals | **Tychem® 6000 F** | Trusted protection against a broad range of chemicals and biohazards | Cat.III, Type 3-B, 4-B, 5-B, 6-B, EN 14126, EN 1073-2, EN 1149-5 |
| Supple protection against a broad range of inorganic and organic chemicals | **Tychem® 4000 S** | A new comfortable alternative against a broad range of inorganic and organic chemicals | Cat.III, Type 3-B, 4-B, 5-B, 6-B, EN 14126, EN 1073-2, EN 1149-5 |
| Concentrated inorganic chemicals | **Tychem® 2000 C** | Comfortable, lightweight protection against biohazards and inorganic chemicals | Cat.III, Type 3-B, 4-B, 5-B, 6-B, EN 14126, EN 1073-2, EN 1149-5 |

# DuPont Product Range

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## Tyvek®

| | | | |
|---|---|---|---|
| Superior protection against particulates and water-based chemical splashes | **Tyvek® 800 J** | The breathable Type 3 garment for protection against water-based inorganic chemicals under pressure | Cat.III, Type 3-B, 4-B, 5-B, 6-B, EN 14126, EN 1073-2, EN 1149-5 |
| | **Tyvek® 600 Plus** | Combining Type 4 performance with the durability, protection and comfort of a Tyvek® garment | Cat.III, Type 4-B, 5-B, 6-B, EN 14126, EN 1073-2, EN 1149-5 |
| | **Tyvek® 500 Labo** | Protecting wearers and processes in laboratories and clean environments | Cat.III, Type 5-B, 6-B, EN 1073-2, EN 1149-5, EN 14126 |
| | **Tyvek® 500 Xpert** | Setting a new standard of protection in the Type 5 and 6 category through greater protection and comfort | Cat.III, Type 5-B, 6-B, EN 14126, EN 1073-2, EN 1149-5 |
| | **Tyvek® 500 Xpert** *Eco Pack* | DuPont™ Tyvek® 500 Xpert now available in a new, more sustainable packaging solution - a significant waste reduction compared to standard Tyvek® 500 Xpert coverall | Cat.III, Type 5-B, 6-B, EN 14126, EN 1073-2, EN 1149-5 |
| | **Tyvek® 500 HP** *Model TY178* | The new solution designed to provide an enhanced barrier function to help protect the full-body harness and its wearer against external chemical threats | Cat.III, Type 5-B, 6-B, EN 14126, EN 1073-2, EN 1149-5 |
| | **Tyvek® 500 HP** *Model TY198* | Solution for wearers needing chemical protection when working at heights | Cat.III, Type 5-B, 6-B, EN 14126, EN 1073-2, EN 1149-5 |
| | **Tyvek® 500 Industry** | Protection for workers and their products, in sensitive industrial environments | Cat.III, Type 5, 6, EN 1073-2, EN 1149-5 |
| | **Tyvek® 500 HV** | All-in-one solution: high-visibility (to the highest class), chemical, biological and antistatic protection in one coverall | Cat.III, Type 5-B, 6-B, EN 14126, EN 1073-2, EN 1149-5, EN ISO 20471, RIS-3279-TOM Issue 1 (replaces GO/RT 3279 Issue 8) |
| | **Tyvek® 400 Dual TG** | Protection from head to toe & fingertips | Cat.III, Type 5, 6, EN 1073-2, EN 1149-5 |
| | **Tyvek® 400 Dual** | Protection and durability in the front, breathability in the back | Cat.III, Type 5, 6, EN 1073-2, EN 1149-5 |
| | **Tyvek® 400 DualFinish** | Front that helps reduce the risk of to stick or delaminate when exposed to tacky resins, comfort in the back | Cat.III, Type 5, 6, EN 1149-5 |
| | **Tyvek® 400 DualCombi** | For environments where comfort is important and exposure risk limited to front | Cat.III, Type PB[6] |
| Good protection against particulates and water based chemical splashes | **Tyvek® 200 EasySafe** | Great breathability and optimised protection for less demanding applications | Cat.III, Type 5, 6 EN 1073-2, EN 1149-5 |

# DuPont Product Range

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## Tyvek® IsoClean®

| | | | |
|---|---|---|---|
| People, process and product protection for controlled environments | **Tyvek® IsoClean® clean-processed and sterile range** *Option DS/MS* | Suitable for GMP A/B, ISO 5 controlled environments | Please check product details |
| | **Tyvek® IsoClean® sterile range** *Option TS/WS* | Suitable for GMP A/B, ISO 5 controlled environments | Please check product details |
| | **Tyvek® IsoClean® non-sterile range** *Option 0B/00* | Suitable for GMP C/D, ISO 6-9 controlled environments | Please check product details |

# DuPont Product Range NEW

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## Tyvek® Emergency Services range

Protective solutions with a new set of performances against biological hazards, and improved comfort for workers in the Emergency Medical Services field, including but not limited to first responders, paramedics, ambulance workers, and emergency services personnel.

| | | |
|---|---|---|
| **Tyvek® 800 ES** | The new Type 3 Tyvek® garment with improved breathability for longer wear time, ideal for delivering health care in high-risk situations, including virus protection ISO 16604 class 5. | Category III, Type 3-B, Type 4-B, Type 5-B, Type 6-B, EN 1149-5, EN 14126, EN 13795-1 |
| **Tyvek® 500 AV** | The first of its kind Type 5 & 6 garment with an Anti-Viral functionality for maximal infection control, help reduce patient risk of cross contamination in medical settings. | Category III, Type 5-B, Type 6-B, EN 1149-5, EN 14126, ISO 18184, EN 13795-1 |
| **Tyvek® 500 ES** | The new Tyvek® 500 ES coverall offers ideal breathability you can get for the level of Biological protection, including virus protection ISO 16604 class 2. | Category III, Type 5-B, Type 6-B, EN 1149-5, EN 14126, EN 13795-1 |
| **Tyvek® 500 ES Gown** | A new gown with enhanced comfort, offers the breathability of medical clothing with the biological protection of a PPE, helping to protect both the wearer and patient from biological risks, including virus protection ISO 16604 class 2. | Category III, Type PB[6-B], EN 1149-5, EN 14126, EN 13795-1 |

# DuPont Product Range

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## ProShield®

| | | | |
|---|---|---|---|
| Limited particulate and liquid protection | **ProShield® 60** | Best in class microporous film at a highly economical price | Cat.III, Type 5, 6, EN 1073-2, EN 1149-5 |
| Flame retardant, limited particulate and liquid protection | **ProShield® 20 SFR** | The solution to protect you and your flame-resistant workwear underneath | Cat.III, Type 5, 6, EN 1073-2, EN 1149-5, EN ISO 14116 |
| Limited particulate and liquid protection | **ProShield® 20** | Based on SMS technology, breathable lightweight coverall for entry-level Type 5, 6 protection | Cat.III, Type 5, 6, EN 1073-2, EN 1149-5 |
| Non hazardous substances | **ProShield® 8 Proper** | Durable, washable and comfortable garment ideal for general maintenance activities | Cat.I |

# Product Part Numbers

To simplify ordering and inventory management, we developed a simple, logical and intuitive product part numbering system. Using only 16 characters, each part number comprises abbreviations that provide all the information you need.

| TY | 120 | S | WH | LG | 0025 | 00 |
|---|---|---|---|---|---|---|

## Fabric

The first two characters are the fabric description.

*Abbreviations*

DuPont™ Tychem®

**TK**
**TF** 6000
**TP** 6000
**SL** 4000
**TC** 2000

DuPont™ Tyvek®

**TJ** 800 J
**TY** 600
**TY** 500
**TY** 400

DuPont™ ProShield®

**PS** 60
**PS** 20
**PS** 20 SFR
**PS** 8 Proper

## Style

DuPont offers a wide array of garment styles—from hoods, aprons and coveralls to fully encapsulated suits. Each garment style has a unique three-digit code.

## Seam Construction

*Abbreviations*

**S** Serged or Sewn
**B** Bound
**T** Taped

See page 16 for details.

## Color

Several DuPont fabrics are available in color options.

*Abbreviations*

**BU** Blue
**GR** Green
**GY** Grey
**LY** Lime Yellow
**OR** Orange
**WH** White
**YL** Yellow
**HV** High visibility Orange

## Size

Many DuPont garments are available in a range of sizes; refer to catalog descriptions for details.

*Abbreviations*

**SM** Small
**MD** Medium
**LG** Large
**XL** Extra large
**2XL** 2 Extra large
**3XL** 3 Extra large
**4XL** 4 Extra large
**5XL** 5 Extra large
**6XL** 6 Extra large
**7XL** 7 Extra large
**00** Universal

See "Step 5" for sizing charts.

Please note that garment/accessory models and sizes are either made to stock or made to order. Make to Stock / Order designations are based on sales volume and production efficiencies. Therefore, designations are subject to change without notice. Please refer to DuPont™ SafeSPEC™ website for more detailed information.

## Case Count

The number of garments per case.

## Options

Option codes for Tyvek® IsoClean® garments*:

**DS/MS** Clean and Sterile
**DS** Individually double packed
**MS** Individually packed subgrouped in an outer bag
**TS/WS** Sterile
**TS** Individually double packed
**WS** Individually packed subgrouped in an outer bag
**0B/00** Non-sterile
Standard packed

* Not all sizes are available in all styles.

# Garment selection: A life saving choice

There are many different chemical protective suits commercially available, and although they are CE certified, there are very wide ranging performance differences for products meeting the same certification 'Types'. Faced with a bewildering choice and the complexity of the certification information, what criteria should be used to select the right protective clothing?

A short summary of the European standards for chemical protective clothing and a chemical protective clothing selection guide is provided to assist you in this task.



CE

### CE Marking

To facilitate the choice of garment, the European Union has defined harmonised product standards for six levels of protection (referred to as 'Types') within Category III chemical protective clothing (see table on next page). The certification of a suit to a particular protection type represents its overall tightness against a particular form of exposure (gas, pressurised liquids, sprays and dust).

It should be noted that its certification does not necessarily mean that the suit is 100% impervious to this type of exposure. It only means that the suit meets the minimum requirements of the specific product standard. The manufacturer is also obliged to state the performance levels of the constituent materials and seams, known as performance 'Classes'.

# Garment selection: A life saving choice

## CHEMICAL PROTECTIVE CLOTHING, CATEGORY III

| Pictogram* | Type | Definition and Exposure Level | Product Standard |
|---|---|---|---|
|  | TYPE 1<br>TYPE 1 - ET | **GAS-TIGHT**<br>TYPE 1 – Protective clothing against liquid and gaseous chemicals, including liquid aerosols and solid particles.<br>TYPE 1 - ET – Performance requirements for emergency teams. | EN 943-1<br>EN 943-2 |
|  | TYPE 2 | **NON-GAS-TIGHT**<br>Protective clothing against liquid and gaseous chemicals, including liquid aerosols and solid particles. | Exists under ISO 16602 |
|  | TYPE 3 | **LIQUID TIGHT**<br>Protective clothing against liquid chemicals.<br>Exposure to pressurised jet of liquid. | EN 14605/A1 |
|  | TYPE 4 | **SPRAY TIGHT**<br>Protective clothing against liquid chemicals.<br>Exposure to a liquid spray aerosol (unpressurised). | EN 14605/A1 |
|  | TYPE 5 | **SOLID PARTICULATES**<br>Protective clothing against solid-airborne particulates. | EN ISO 13982-1/A1 |
|  | TYPE 6 | Limited protective performance against liquid chemicals. Potential exposure to small quantities of fine spray/mist or accidental low volume splashes and where wearers are able to take timely adequate action in case of contamination. | EN 13034/A1 |

* DuPont Pictogram.

# Garment selection: A life saving choice

## OTHER RELEVANT STANDARDS

| Pictogram* | Definition | Standard* |
|---|---|---|
|  | Protective clothing with electrostatic properties – material performance and design requirements. | EN 1149-5 |
|  | Protective clothing against radioactive contamination. | EN 1073-2 |
|  | Protective clothing with protection against heat and flame-Limited flame spread materials, material assemblies and clothing. Three 'Index' (levels) of protection are defined: Index 1 performance: single use and no pre-cleaning or laundering. Index 1 materials limit the flame spread, but will melt and must always be worn on top of Index 2 or 3 garments. | EN ISO 14116 |
|  | Protective clothing (fabrics) against infective agents (indicate by a 'B' e.g. Type 3-B) and comprising several fabric protection test methods. | EN 14126 |
|  | High-visibility clothing - Test methods and requirements. | EN ISO 20471 |
|  | Respiratory protective devices - Continuous flow compressed air line breathing devices | EN 14594 |
|  | Antiviral properties (reducing the viral load after a specific contact time) | ISO 18184 |
|  | Surgical clothing and drapes | EN 13795-1 |

* As standards are continuously revised the year of publication is subject to change. ** Antistatic treatments on DuPont chemical protective clothing are only effective in relative humidity >25% and when the garment and wearer are continuously and correctly grounded. *** Does not protect against ionizing radiation.

# Garment selection :
# The 9-step guide from DuPont

**Faced with a huge array of potential hazards, a bewildering choice of protective clothing and the complexity of the certification information, what criteria should be used to select the right protective clothing?**

This Selection Guide and the ensuing sections provide you with a summary of the European Standards for Personal Protective Equipment (PPE) and further information on which to base your decisions.

Workers can potentially be exposed to a multitude of workplace and environmental hazards. These include asbestos, dioxins, oils, lubricants, paints, blood and biological hazards, nuclear, phytosanitary products, organic chemicals, heat and flame risks and there are many different factors such as concentration, temperature, pressure that can have a significant influence on the risks posed by these threats. In addition, the physical nature of these threats can take many forms including liquid, gaseous, fine dusts, solid particles, fibres, sprays, aerosols, splashes and radioactive particles. Furthermore, in many workplace environments there are multiple protection requirements that need to be considered and, of course, every hazard environment and every exposed person is different. Which means that the choice of protective clothing has to take into account a host of physiological and psychological factors that combine to influence a garment's effectiveness and its 'wearability' in 'real life' exposure situations.

The fact that all of these complicated and interactive factors must be considered as a whole makes the selection of the optimum protective clothing an extremely difficult and daunting task. To ensure that all the appropriate precautions are taken requires thorough workplace risk assessments to be conducted at periodic intervals to ensure the short term safety and/or long-term health and well-being of the workers.

This process of selecting, and regularly reviewing, protective clothing that is safe, effective and comfortable is an extremely important task and should never be overlooked or undervalued.

Within the context of an overall risk analysis **9 STEPS** presented on the next page, should be followed (in alignment with national legislation / recommendations) to arrive at the most appropriate protective clothing.

**IMPORTANT**

**If you are new to protective clothing and do not know exactly which garment(s) you need, or if you require further information on garment selection please read this section first.**

# Garment selection : The 9-step guide from DuPont

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STEP 1

## Hazard identification



STEP 2

## Determine minimum levels of protection needed




STEP 3

## Assess hazard



Warning

STEP 4

## Determine protective performance requirements of the fabric and seam



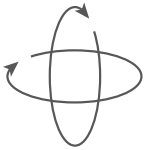
STEP 5

## Determine mechanical performance requirements



STEP 6

## Comfort considerations



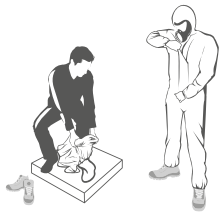
STEP 7

## Supplier selection




STEP 8

## Identify the correct usage of the product



STEP 9

## Wear test



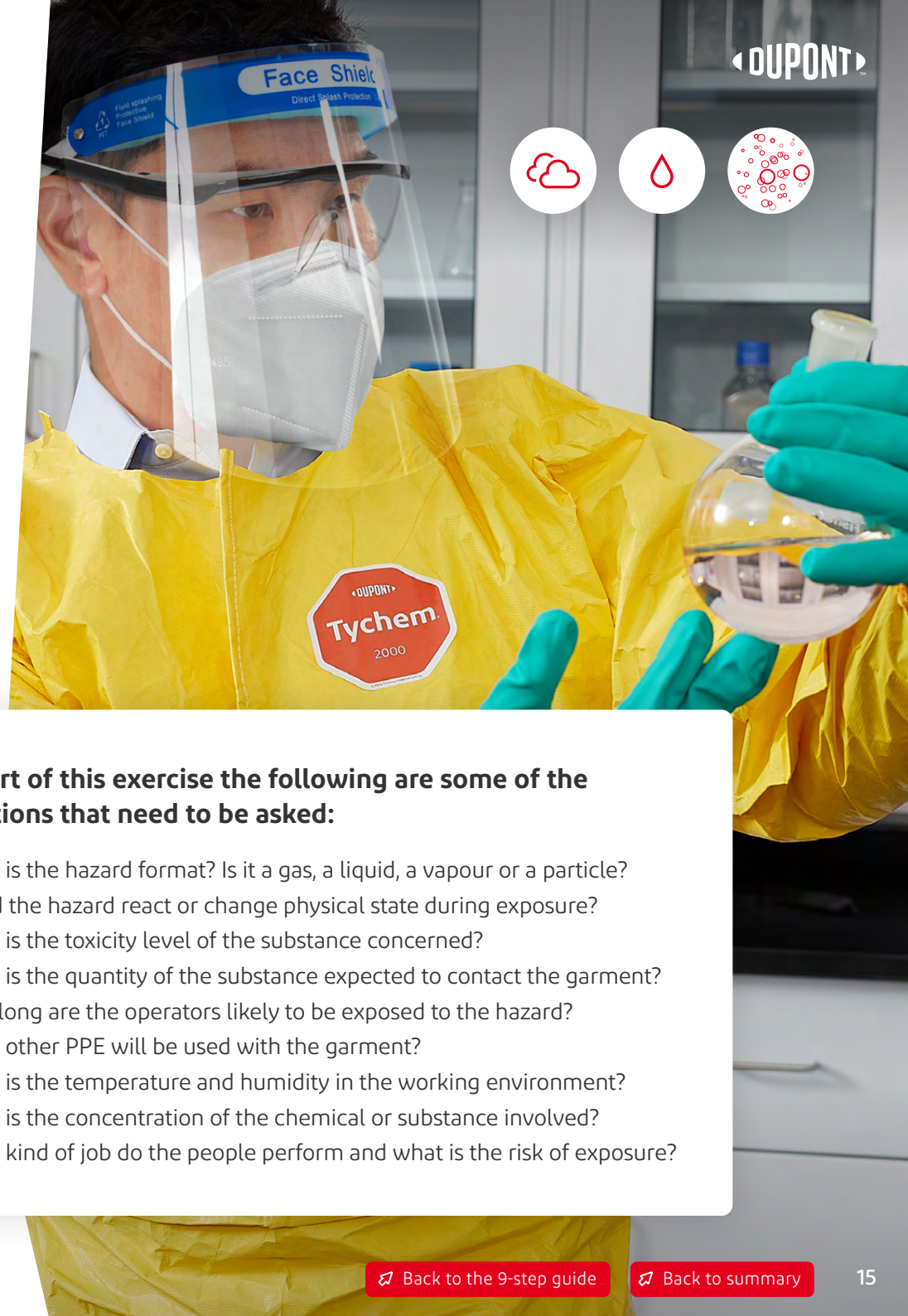
## STEP 1

# Hazard identification

**The first step** in selecting protective garments as part of a comprehensive personal protective equipment (PPE) programme is to conduct a detailed assessment of the working environment(s) concerned and the nature of the hazard(s) that are, or may be, present.

### This risk analysis might take the following form:

1. Objectively identify the potential hazards including their sources and any associated trigger events. A suitable hazard assessment form or software package might be used for this purpose.
2. Determine those who might be affected by exposure to a hazard and in what circumstances.
3. Evaluate the risks and what steps are available for prevention, mitigation and protection. At all times consult with operatives and their representative bodies.
4. Incorporate the findings into a formal risk assessment document which can be shared, and expanded as necessary.
5. Put the risk assessment findings into practice, and make sure you have contingency plans in place for the unexpected.
6. Continuously re-examine procedures, training and equipment as necessary and periodically conduct a formal review of the entire risk assessment programme.



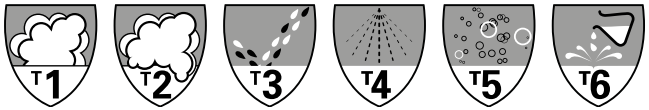

### As part of this exercise the following are some of the questions that need to be asked:

- What is the hazard format? Is it a gas, a liquid, a vapour or a particle?
- Could the hazard react or change physical state during exposure?
- What is the toxicity level of the substance concerned?
- What is the quantity of the substance expected to contact the garment?
- How long are the operators likely to be exposed to the hazard?
- What other PPE will be used with the garment?
- What is the temperature and humidity in the working environment?
- What is the concentration of the chemical or substance involved?
- What kind of job do the people perform and what is the risk of exposure?

STEP 2




# Determine minimum levels of protection needed




In other words, determine the degree(s) of exposure level(s) to identify a potential suitable minimum garment 'CE-Type'. The designation of six separate 'Types' of protection within CE Category III chemical protective clothing is intended to facilitate the selection as a function of the nature of the hazard exposure. Certification to a particular protection Type represents the tightness of the garment against a particular form of exposure (gas, liquid or dust). However it does not mean that the item is 100% impervious to this type of exposure.

## STEP 3

# Assess hazard

Knowing the toxicity or consequences of short- or long-term exposure to a hazard is essential. With this in mind, consider whether a coverall has been tested to the following standard: EN ISO 6529 which gives information concerning the chemical permeation and penetration of the fabric where the chemical is tested up to 480 minutes and a minimum of 10 minutes. Further assistance can be accessed in the Instructions for Use attached to DuPont products packaging, where you can find permeation data for a selection of chemicals.

**NEW!**
**Download the new mobile app!**

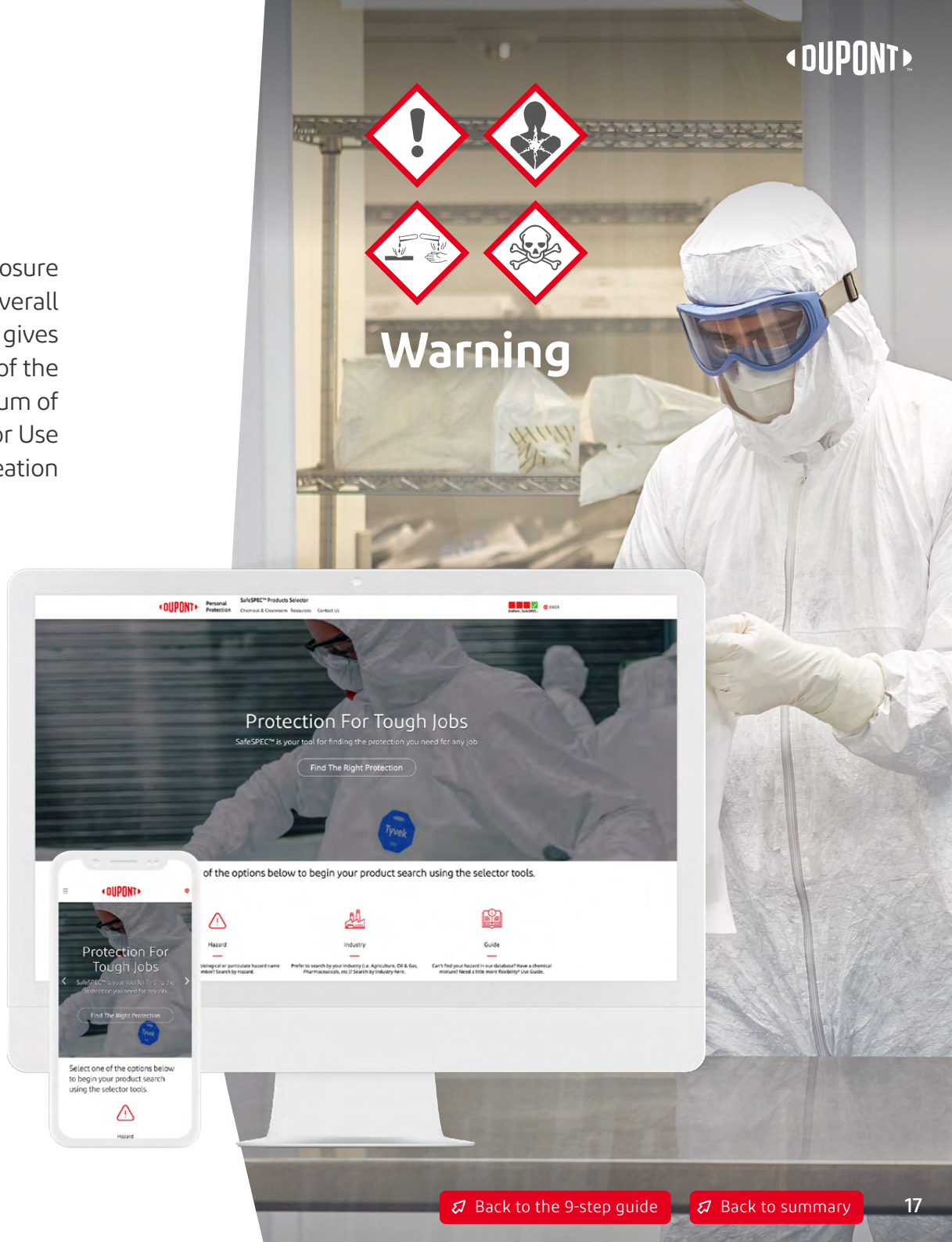
DuPont™ SafeSPEC™

**Detailed permeation data for over than 450 chemicals can be accessed on**

**safespec.dupont.co.uk**

GET IT ON Google Play

Download on the App Store





# Determine protective performance requirements of the fabric and seam

## Seam construction

Seams are a critical component of the overall barrier protection provided by a chemical protective garment. It is vital to select the appropriate seam configuration for your application needs and to know that the garment will be constructed with strong, tight seams. One loose thread or gap and the barrier between you and your environment unravels—leaving you vulnerable.

## Fabric

No matter what the brand or trade name, almost all limited-use protective apparel products can be classified into one of a few general fabric technologies. It is important to understand the performance attributes of the fabric being used for a given application. Why? Not all fabrics used in chemical protective garments are the same. From exclusive DuPont technologies such as DuPont™ Tychem® and DuPont™ Tyvek® to SMS and microporous film fabrics, DuPont offers a variety of fabrics with different levels of comfort, durability, breathability and protection to meet your specific needs.

In order to select the appropriate protective garment, it is crucial to know how well the fabric used in the garment provides a barrier to specific hazardous materials. Testing for chemical protective fabrics can be divided into two primary categories:

1. penetration testing - appropriate for particle hazards
2. permeation testing - appropriate for liquid and gaseous hazards

Penetration occurs when there is bulk movement of a material through a pore, hole, gap or defect in the fabric and is the proper method to evaluate particle barrier. Permeation, on the other hand, occurs when there is movement of the material through the barrier fabric on a molecular level. It is possible for a liquid or vapor to permeate through a fabric even when there is no observed opening in the fabric. Permeation testing is a more sensitive and representative way of characterizing the interaction of liquids and gases with the barrier fabric. Permeation testing is critical for fabrics that are exposed to hazardous liquids, vapors or gases.

## STEP 5

# Determine mechanical performance requirements

Fabric performance is critical, but it is only as good as the integrity of the garment itself. Excellent fabric barrier properties are only of value if they remain intact for the duration of the task and can withstand the working conditions. Consequently, in addition to the requirements for barrier performance, protective clothing must be considered from a 'whole garment' perspective taking into account factors such as the fabric's mechanical properties such as strength, abrasion resistance, susceptibility to tearing, and seam integrity. To assess these qualities it is highly recommended that all garments under consideration are subjected to wear trials under 'actual conditions' of use (please see **Step 8**).

Two important factors that contribute to protection-in-use (and overlap with comfort and ease-of-use considerations are garment sizing and garment fit (please see donning and doffing videos). The correct size and cut of a protective coverall has a huge impact on the protection provided to the wearer and is a significant determinant of comfort and ease of use. Garments must be available in a full range of sizes to suit different physical and gender characteristics, must be of a non restrictive, ergonomic fit, compatible with other PPE items, and yet not be so bulky as to present undue risk of snagging, tearing or tripping.

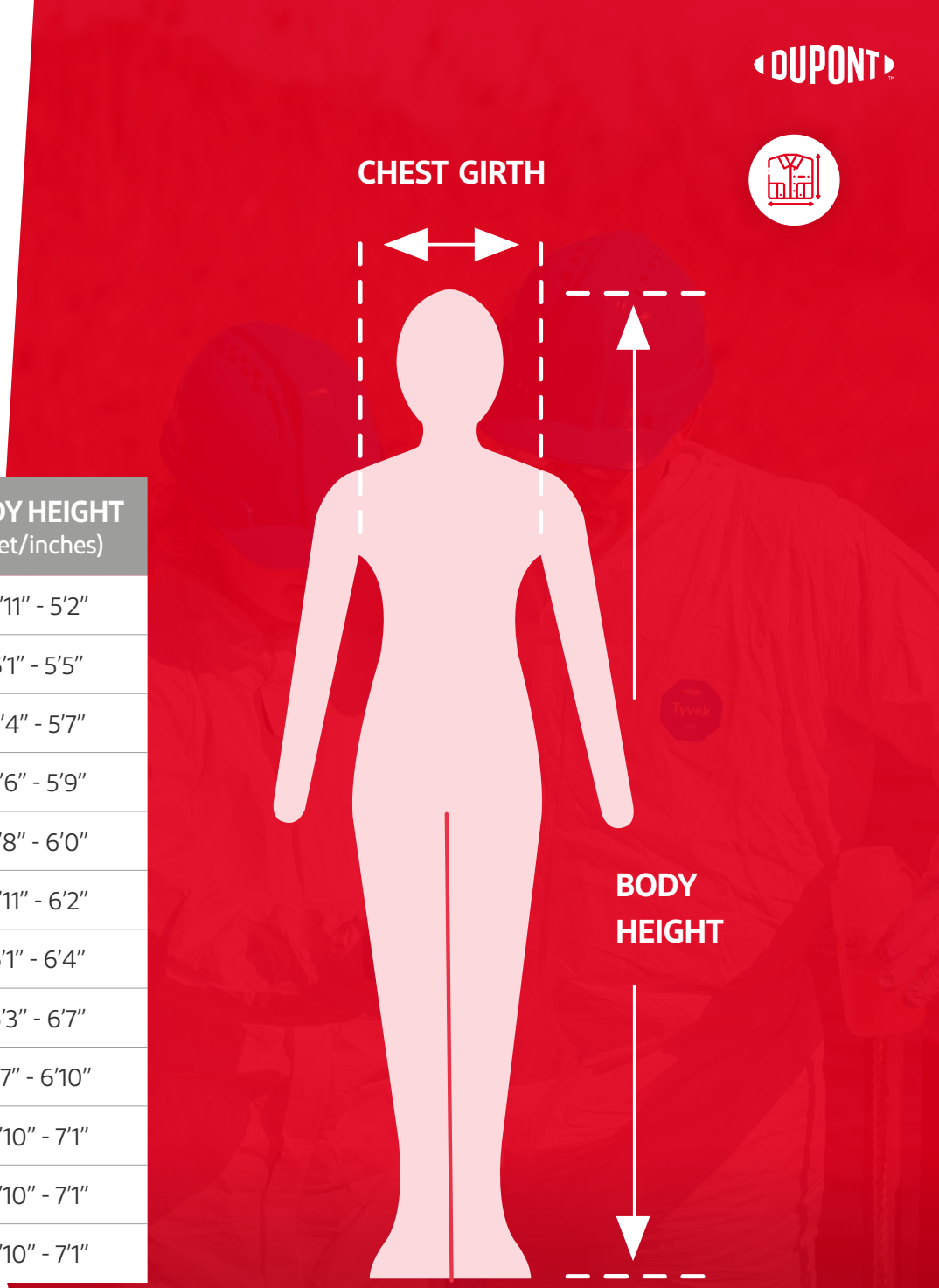


## STEP 5

# Determine mechanical performance requirements

### BODY MEASUREMENTS CM/INCH

| SIZE | CHEST GIRTH (cm) | BODY HEIGHT (cm) | CHEST GIRTH (inches) | BODY HEIGHT (feet/inches) |
|---|---|---|---|---|
| XXS | 68 - 76 | 150 - 158 | 27 - 30 | 4'11" - 5'2" |
| XS | 76 - 84 | 156 - 164 | 30 - 33 | 5'1" - 5'5" |
| SM | 84 - 92 | 162 - 170 | 33 - 36 | 5'4" - 5'7" |
| MD | 92 - 100 | 168 - 176 | 36 - 39 | 5'6" - 5'9" |
| LG | 100 - 108 | 174 - 182 | 39 - 43 | 5'8" - 6'0" |
| XL | 108 - 116 | 180 - 188 | 43 - 46 | 5'11" - 6'2" |
| 2XL | 116 - 124 | 186 - 194 | 46 - 49 | 6'1" - 6'4" |
| 3XL | 124 - 132 | 192 - 200 | 49 - 52 | 6'3" - 6'7" |
| 4XL | 132 - 140 | 200 - 208 | 52 - 55 | 6'7" - 6'10" |
| 5XL | 140 - 148 | 208 - 216 | 55 - 58 | 6'10" - 7'1" |
| 6XL | 148 - 156 | 208 - 216 | 58 - 61 | 6'10" - 7'1" |
| 7XL | 156 - 162 | 208 - 216 | 61 - 64 | 6'10" - 7'1" |






# Comfort considerations

## Garment style

DuPont offers a wide variety of garment styles - from hoods and shoe covers to aprons, coveralls and fully encapsulated suits. Fully encapsulated suits are available with front or rear entry, with a flat back for airline accommodation or an expanded back for SCBA accommodation.

Effective protection is vital, but so is wearer comfort. When it comes to 'day-in day-out' health and safety compliance, operator comfort is one of the key 'human factors' that govern the correct use of Personal Protective Equipment (PPE). The importance of wear-comfort and correct garment fitting cannot be overstated. A large proportion of observed PPE non-compliance occurrences are not due to an absence of protection but are simply due to workers shunning, misusing or abusing the protection provided. And even where staff are wearing the appropriate equipment, if it doesn't fit or if it isn't comfortable then it is often being worn incorrectly. Identifying the appropriate protective and mechanical performance, yet, at the same time, maximising wearer comfort is a critical part of the selection equation and will significantly contribute to correct coverall use with optimised wearer satisfaction and productivity. As with protection-in-use (please see Step 5) it is essential that donning and doffing procedures are developed and practised (Step 8) and user wear trials (Step 9) are conducted to assess the perceived comfort-in-use of the garment(s) being considered.

## STEP 7

# Supplier selection

When evaluating protective garments on which the health and safety of workers depend it is important to take into account the the manufacturer's reputation, accreditations, strength of brand, business credentials, ethical standing and environmental record, in addition to the basic garment requirements. An exceptional manufacturer of protective clothing will actively embrace the principles of customer service and business integrity and these core values will be embedded throughout the organisation. It will be committed to the highest standards of quality, safety, respect for people, corporate governance and environmental stewardship all of which will have been translated into publicly-available policies and procedures.

At a product level the manufacturer should ensure that in addition to the highest standards of quality, the protective garments should not contain hazardous or banned ingredients or hazards to the ecosystem, and be REACH compliant. Garment production facilities, whether in-house or outsourced, must embrace the principles of safety, employee welfare and social responsibility and be managed and periodically audited to ensure compliance. The manufacturer should provide a high level of pre- and after-sales service and support ideally including training programmes, testing services, selection tools, risk-analysis guidance and permeation data.

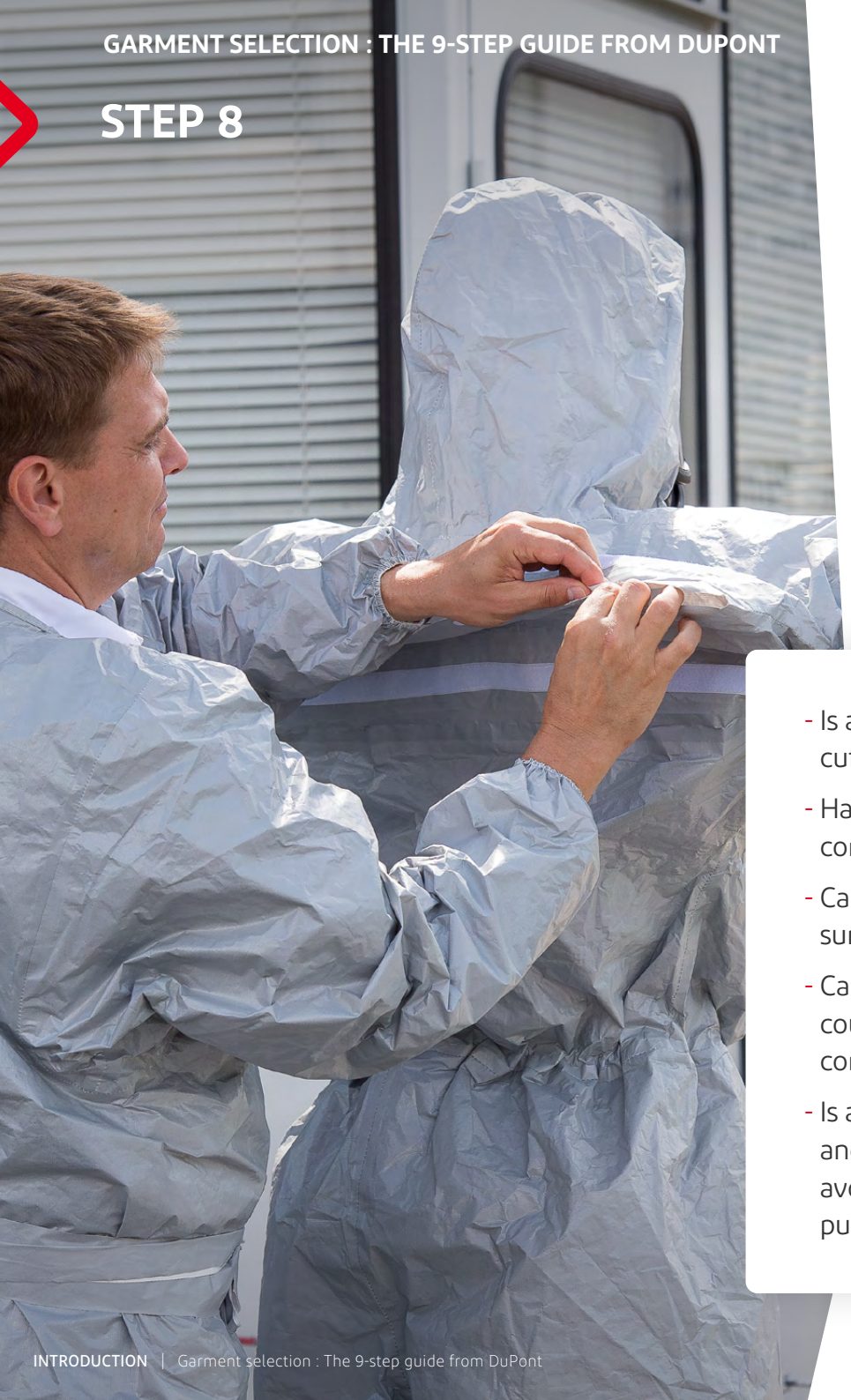



**Some additional questions you might ask potential suppliers include:**

- Does the company offer Customer Service support (technical support hotline, customer focused websites and tools, wear trials)?
- Does the company offer open access to product data e.g. can the company provide comprehensive permeation data for its products?
- Can it demonstrate exemplary case studies/user references?
- What is the product development process?
- Is Corporate Social Responsibility (CSR) one of the company's core corporate principles or business objectives? Does the company publish a CSR Policy or issue regular CSR reports?
- Does the company have a formal Sustainability Policy?
- Has the company publicized a Code of Conduct/Ethics?
- Is the company ISO 14001 registered for Environmental Management Systems?
- Does the company have a rigorous Quality Management System (QMS) in place and operate a Quality Management System to ISO 9001?
- What is the company's trading background?
- Is the company financially secure?
- How is the company perceived in the media?



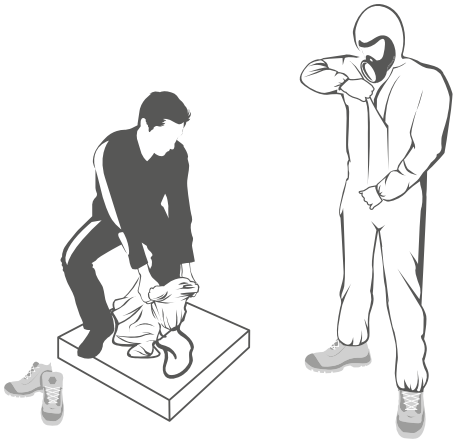
STEP 8



# Identify the correct usage of the product

Ensure proper training is provided for correct donning, doffing and usage and be aware of product limitations. Note that the manufacturer's Instructions for Use, sometimes disregarded or overlooked, can be a useful source of information on the correct use of the product and any limitations. Please make sure you answer questions, as for example:

- Is additional taping required e.g. to the mask, cuffs, ankles?
- Have earthing requirements been considered for the wearer and the coverall?
- Can the wearer come into contact with sharp surfaces that could damage the garment?
- Can the suit come into hot surfaces that could melt the fabric or open the seams (e.g. contact with hot pipes or steam cleaning)?
- Is a donning and doffing procedure required and does this procedure need training to avoid contamination when the garment is put on and removed?



## STEP 9

# Wear test

A detailed examination of technical performance data and product standards is only the first part of the product selection process. Once a product has been selected which meets the required performance criteria on paper it is then important to conduct 'in-use' wear trials to test and evaluate the product performance in use. This will include using the garments part of an appropriate PPE ensemble to ensure full 'in-use' compatibility under expected operating conditions. In these user tryout exercises endeavour to involve as many people as possible and ask them to complete a standard evaluation form at the conclusion of the trial. Depending on the nature of the work it may be necessary to conduct these trials over a period of days or even weeks in order to evaluate the performance of the garments under live conditions but this will be time well spent if it results in the correct and most cost efficient choice of protection. Please contact your DuPont representative or distributor to get a wear-trial form.

TRY IT!




The result will be a choice of garment that fulfils user expectations in terms of fit, function, comfort, performance, durability and, of course, safety.

# Garment selection: DuPont™ SafeSPEC™ Online Selector Tool

DuPont offers a range of support tools to assist with risk assessment and garment selection: ranging from web-based tools and on-site risk assessment support with DuPont Personal Protection specialists and chemists, to chemical permeation barrier testing for your specific chemicals.

SafeSPEC™, our powerful online tool, can help you determining your most suitable protective garments among more than 1000 scenarios!

**safespec.dupont.co.uk**

NEW

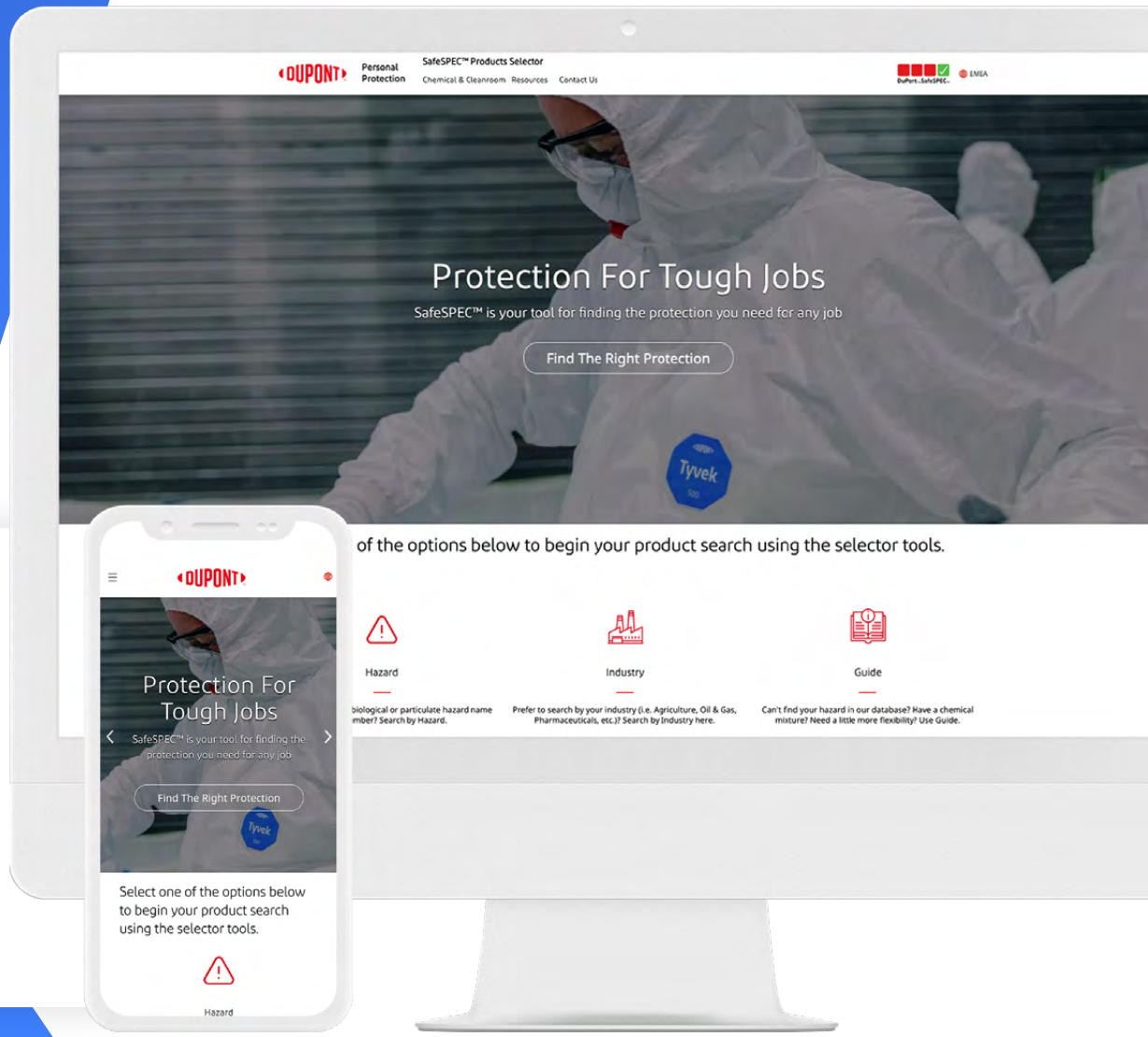
## The SafeSPEC™ Mobile App

Is now live globally, available on AppStore or Google Playstore in 8 languages.

Please download using the following links or by searching “Safespec”

GET IT ON Google Play

Download on the App Store



# Training, storage and other ongoing considerations




Procuring the correct PPE is only the first part of the equation. It then has to be stored, maintained, used correctly, disposed of and replaced. Shelf-life of the PPE should be considered to store boxes for a certain period of time. Most importantly, users must be correctly trained in its use. Employers, in addition to continually assessing workplace hazards as part of an interactive health and safety programme, must keep abreast of all technical and legislative developments relating to workplace safety and modify all safety policies and procedures as necessary.

# Recommended donning & doffing procedures for chemical protective clothing

Follow the steps recommended below to dress and undress in a safe and simple manner, thereby limiting any potential for contamination after working in a hazardous environment.

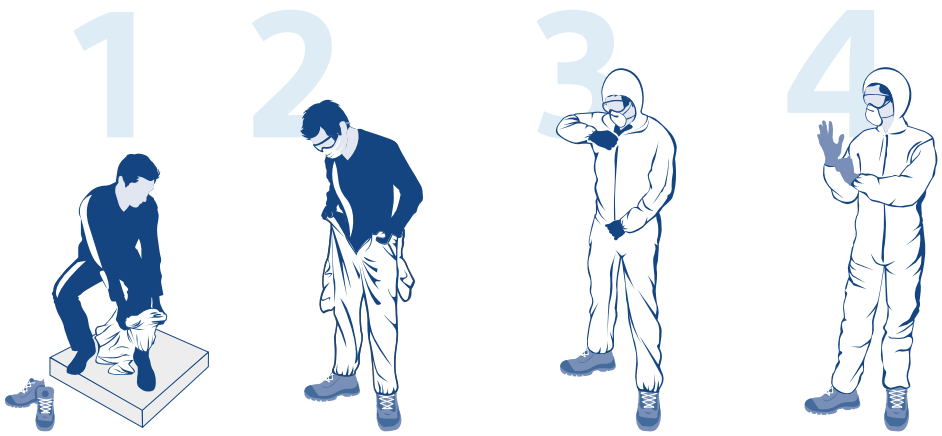
## The right size for increased protection and comfort

| SIZE (CM) | SM | MD | LG | XL | 2XL | 3XL | 4XL | 5XL | 6XL | 7XL |
|---|---|---|---|---|---|---|---|---|---|---|
| | 84 - 92 | 92 - 100 | 100 - 108 | 108 - 116 | 116 - 124 | 124 - 132 | 132 - 140 | 140 - 148 | 148 - 156 | 156 - 162 |
| | 162 - 170 | 168 - 176 | 174 - 182 | 180 - 188 | 186 - 194 | 192 - 200 | 200 - 208 | 208 - 216 | 208 - 216 | 208 - 216 |

**Typical products following this procedure:**

Tyvek® 800 J, Tyvek® 600 Plus*, Tyvek® 500 Labo, Tyvek® 500 Xpert, Tyvek® 500 HP, Tyvek® 500 Industry, Tyvek® 500 HV, Tyvek® 400 Dual, Tyvek® 400 DualFinish, Tyvek® 400 DualCombi, Tyvek® 200 EasySafe

## DONNING




## DOFFING




* For Tyvek® 600 Plus and Tyvek® 800 J, use self-adhesive tape to seal the zipper and chin flaps.

# Recommended donning & doffing procedures for chemical protective clothing

Follow the steps recommended below to dress and undress in a safe and simple manner, thereby limiting any potential for contamination after working in a hazardous environment.

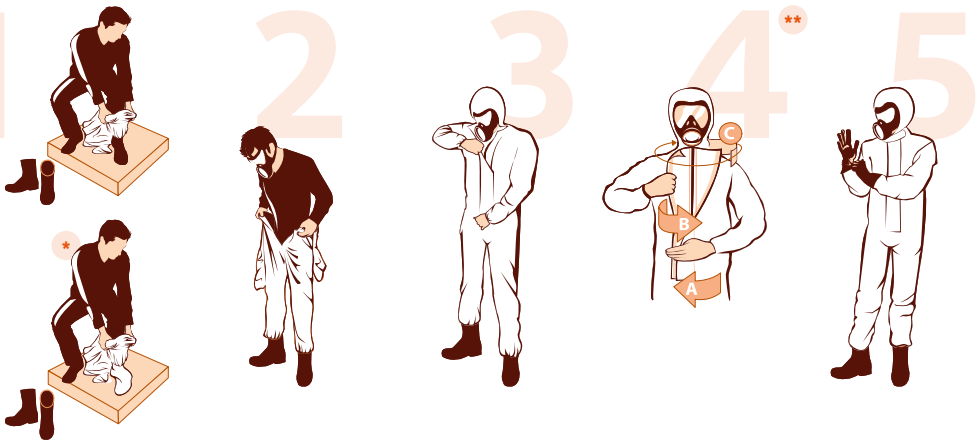
## The right size for increased protection and comfort

| SIZE (CM) | SM | MD | LG | XL | 2XL | 3XL | 4XL | 5XL |
|---|---|---|---|---|---|---|---|---|
| | 84 - 92 | 92 - 100 | 100 - 108 | 108 - 116 | 116 - 124 | 124 - 132 | 132 - 140 | 140 - 148 |
| | 162 - 170 | 168 - 176 | 174 - 182 | 180 - 188 | 186 - 194 | 192 - 200 | 200 - 208 | 208 - 216 |

**Typical products following this procedure:**

Tyvek® 600 Plus, Tyvek® 800 J,
Tychem® 2000 C, Tychem® 4000 S,
Tychem® 6000 F

## DONNING




## DOFFING




*Garment with integrated socks only **We recommend to request second person's help to stick the flap properly, and to remove the garment without getting contaminated. In case no one can help, the use of a mirror is recommended.

DUPONT™

# Tychem®

## Garments & Accessories




Back to summary

# Tychem® TK

## Effective barrier against more than 300 chemicals.

- ✓ Specifically developed to help protect against toxic and corrosive gases, liquids and solid chemicals.
- ✓ Fabric, visor, inner layer glove and seams meet required resistance to permeation for chemicals listed in EN 943-2.
- ✓ Out of the 300 chemicals tested, no observable breakthrough in tests for 270 chemicals after 8 hours of exposure.
- ✓ Puncture- and tear-resistant.

Oil and gas

Emergency response

Chemical industry

| | |
|---|---|
| **Reference:** | TK GEVH T YL 00 (WITH SOCKS)<br>TK GEVJ T YL 00 (WITH BOOTS) |
| **Colour:** | Lime yellow |
| **Size:** | SM to 2XL (ALL SIZES ARE MTO)<br>Available boot sizes EU size 35 - 50 |

MTO = Made to order.



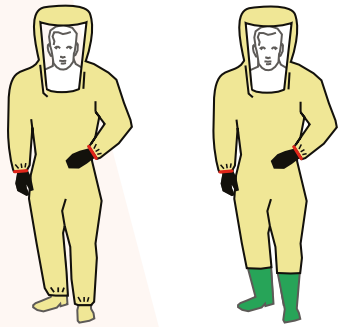
Gas-tight zip closure



Attached gloves



Option: hazmat chemical boots





Category III

TYPE 1a -ET

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# Tychem® 6000 AL NEW
## (Air-Line)

### An air-fed suit made for extremes. Two PPE (Body & Respiratory) into one ensemble.

- ✓ DuPont™ Tychem® 6000 AL coverall helps provide maximum protection* against various harmful chemicals in liquid, spray, aerosol and mist form as well as solid particles including radioactive particulates. It comes in four options to meet the needs of different applications!
- ✓ This innovative garment features a fully enclosed over hood with crown see through visor and clear front that provides 180 degree panoramic view. Optional attached dissipative socks, under gloves, and over boots help provide head-to-toe protection that is adaptable to your preferences.
- ✓ The suit's ventilation system is designed to maximise the wearer's comfort and ease of use. Emergency egress strip for a quick doffing in case of emergency.

Chemical | Pharmaceutical** | Oil and gas industries

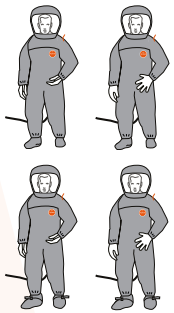
| | |
|---|---|
| **Reference:** | TF 630 T GY 00 (WITH ATTACHED DISSIPATIVE SOCKS)<br>TF 630 T GY WG (WITH ATTACHED DISSIPATIVE SOCKS AND UNDER GLOVES)<br>TF 640 T GY 00 (WITH ATTACHED DISSIPATIVE OVER BOOTS)<br>TF 640 T GY WG (WITH ATTACHED DISSIPATIVE OVER BOOTS AND UNDER GLOVES) |
| **Colour:** | Grey |
| **Size:** | SM to 3XL (ALL MTO) |


Air-line belt inside the coverall


Under gloves


Air-line connector & 2 air valves


Supplied system for the airline







Visor design with 180° panoramic view


Emergency strip


Double flap hook and loop


Attached dissipative over boots

Category III

TYPE 3-B

TYPE 4-B

TYPE 6-B

EN 1149-5

EN 14126

EN 1073-1

EN 14594

MTO = Made to order.
* The user must ensure suitable reagent to garment compatibility before use. Please refer to chemical permeation data available in SafeSPEC™ to determine the level of protection needed. ** Hazardous powders & cytostatic chemicals.

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# Tychem® 6000 AL

## Product details & available models

DONNING DOFFING









| Tychem® 6000 AL model TF 630 00 | Tychem® 6000 AL model TF 630 WG | Tychem® 6000 AL model TF 640 00 | Tychem® 6000 AL model TF 640 WG |
|---|---|---|---|
| No gloves | Attached chemical protective gloves | No gloves | Attached chemical protective gloves |
| With cuff elastication | With attached *non-dissipative* under **gloves** | With cuff elastication | With attached *non-dissipative* **under gloves** |
| Attached Socks w/ Boot flap | Attached Socks w/ Boot flap | Attached Over-boots (ESD) | Attached Over-boots (ESD) |
| Integrated **dissipative socks** & elastic thumb loop on inner sleeve opening | Integrated **dissipative socks** | Over boot assembly consisting of integrated *dissipative inner boots* attached to **dissipative outer boots** with buckles and elastic thumb loop on inner sleeve opening | Over boot assembly consisting of integrated *dissipative inner boots* attached to **dissipative outer boots** with buckles |
| SM – 3XL | SM – 3XL | SM – 3XL | SM – 3XL |

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# Tychem® 6000 F

## FACESEAL

### Tight design combined with trusted Tychem® protection.

- ✓ Tight design technologies: rubber seal around the mask offers good compatibility with full face mask and sealed in gloves for full body protection.
- ✓ No need for taping, enables faster donning in emergency situations and industrial applications.
- ✓ Rear entry with double flaps for enhanced safety of the wearer from frontal exposure.
- ✓ Attached dissipative socks with boot flap.
- ✓ Enables earthing of the wearer through dissipative boots without need for additional earthing cables.
- ✓ Specially for emergency responder teams who may stock the garments for longer periods of time, the manufacturing date is featured on the box packaging.

Chemical spill clean-up

Emergency response

Industrial manufacturing and cleaning

| | |
|---|---|
| **Reference:** | TF 0611 T GY UG |
| **Colour:** | Grey |
| **Size:** | SM to 5XL (SIZES SM, 4XL AND 5XL ARE MTO) |

MTO = Made to order. * Does not protect against ionizing radiation.



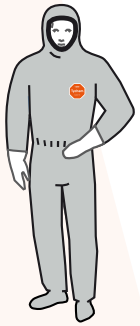
Tight fitting hood

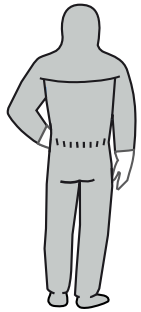


Double zipper flap



Double cuffs with attached undergloves on inner cuff







Category III

TYPE 3-B

TYPE 4-B

TYPE 5-B

TYPE 6-B

EN 1149-5

EN 1073-2* Class 1

EN 14126

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# Tychem® 6000 F Plus

## Tychem® 6000 F barrier in new innovative designs.

- ✓ Smart design features: innovative hood which fits perfectly full face masks, double cuffs, double zippers & double flaps.
- ✓ Inside knitted cuffs for enhanced comfort.
- ✓ Lightweight, durable Tychem® 6000 F fabric (<500 g per garment).
- ✓ The garment can be reused if it is not contaminated or damaged.
- ✓ Available with additional design options: with attached gloves, with dissipative socks, with attached gloves and dissipative socks.



Tape can be used for a tight connection between the coverall and other PPE



Double zipper system



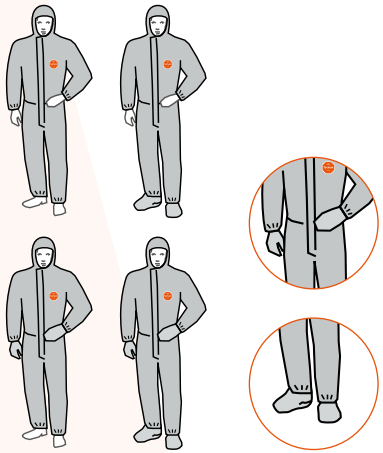
Double cuffs



Chemical spill clean-up

Emergency response

Petrochemical applications



| | |
|---|---|
| **Reference:** | TF CHZ5T GY 00 (STANDARD) |
| **Colour:** | Grey |
| **Size:** | SM to 5XL |

* Does not protect against ionizing radiation.

Category III

TYPE 3-B

TYPE 4-B

TYPE 5-B

TYPE 6-B

EN 1149-5

EN 1073-2* Class 1

EN 14126

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# Tychem® 6000 F Plus




| | |
|---|---|
| **Reference:** | TF CHZ5T GY 08<br>(WITH ATTACHED GLOVES)* |
| **Colour:** | Grey |
| **Size*:** | SM to 5XL |




| | |
|---|---|
| **Reference:** | TF CHZ5T GY 18<br>(WITH DISSIPATIVE SOCKS)* |
| **Colour:** | Grey |
| **Size*:** | SM to 5XL |




| | |
|---|---|
| **Reference:** | TF CHZ5T GY 26<br>(WITH ATTACHED GLOVES AND DISSIPATIVE SOCKS)* |
| **Colour:** | Grey |
| **Size*:** | SM to 5XL |

* All sizes are made to order.

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# Tychem® 6000 F

## WITH DISSIPATIVE SOCKS

**Dissipative Socks smart solution that allows grounding of a wearer from inside through conductive shoes and floor without additional wiring.**

- ✓ Tested according to EN 61340-4-5:2014 with adapted test conditions of air temperature 22±1°C and relative humidity of 25±3% as per EN 1149-1 to evaluate earthing feasibility thru adequate footwear.
- ✓ Earthing through dissipative footwear as alternative to earthing cord.
- ✓ Hooded coverall with attached dissipative socks and boot flap. Stitched and over-taped seams. Thumb loops. Elasticated at the wrists, face and waist. Grey colour.

Chemical spill clean-up

Emergency response

Petrochemical applications

| | |
|---|---|
| **Reference:** | TF CHA6 T GY 16 (WITH SOCKS) |
| **Colour:** | Grey |
| **Size:** | SM to 3XL (SIZE SM IS MTO) |

MTO = Made to order. * Does not protect against ionizing radiation.



Self-adhesive chin and zipper flap



Thumb loops



Dissipative socks








Category III

TYPE 3-B

TYPE 4-B

TYPE 5-B

TYPE 6-B

EN 1149-5

EN 1073-2* Class 1

EN 14126

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# Tychem® 6000 F

## Trusted protection against a broad range of chemicals and biohazards.

- ✓ Protection against numerous toxic industrial organic chemicals, highly concentrated inorganic chemicals and biohazards. Chemical permeation data available for more than 250 chemicals.
- ✓ Protective seams, stitched and over-taped with barrier-tape, providing barrier performance equal to that of the fabric.
- ✓ Double self-adhesive zipper flap offers high level of protection.
- ✓ Option for grey model: Socks attached to the ankle: to be worn inside safety boots or shoes with additional knee-length boot flap to help ensure a high protection level.

Chemical spill clean-up

Emergency response

Petrochemical applications

| | |
|---|---|
| **Reference:** | TF CHA5 T GY 00<br>TF CHA5 T OR 00<br>TF CHA5 T GY 16 (WITH SOCKS) |
| **Colour:** | Grey or orange |
| **Size:** | Grey: SM-3XL (GREY WITH SOCKS - SIZE SM IS MTO)<br>Orange: MD-5XL (SIZES 3XL TO 5XL ARE MTO) |

MTO = Made to order. * Does not protect against ionizing radiation.



Self-adhesive chin and zipper flap



Thumb loops



Also available with socks






Category III

TYPE 3-B

TYPE 4-B

TYPE 5-B

TYPE 6-B

EN 1149-5

EN 1073-2*
Class 1

EN 14126

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# Tychem® 6000 F

## ACCESSORIES*

**Tychem® 6000 F accessories can offer enhanced protection of body parts that are more exposed to hazardous substances.**

CE Category & Type

| Category III | TYPE PB[3-B]* | EN 14126 |
|---|---|---|



### Tychem® 6000 F Gown

Knitted cuff for better comfort.
Double cuffs for increased protection and tighter connection with gloves.
Mandarin collar for improved neck and throat area closure.

| | |
|---|---|
| **Reference:** | TF 0290 T GY 00 |
| **Colour:** | Grey |
| **Size**:** | SM/MD, LG/2XL and 3XL/5XL |



### Tychem® 6000 F Apron

Shin-length apron with neck and waist ties.

| | |
|---|---|
| **Reference:** | TF PA30 T GY 00 |
| **Colour:** | Grey |
| **Size:** | One size |



### Tychem® 6000 F Sleeve

50 cm long and with wide elastics at cuffs and upper arm.

| | |
|---|---|
| **Reference:** | TF PS32 T GY 00 |
| **Colour:** | Grey |
| **Size:** | One size |



### Tychem® 6000 F Boot cover

Knee-length overboot with slip-retardant sole. Fixation ties.
Sole is partially stitched: splash-resistant, not fully liquid tight.

| | |
|---|---|
| **Reference:** | TF POBA S GY 00 |
| **Colour:** | Grey |
| **Size:** | One size |

* Partial body protection. ** Size 3XL/5XL is MTO.

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# Tychem® 4000 S

## A comfortable alternative against a broad range of inorganic and organic chemicals.

- ✓ Offers a barrier to permeation for more than 100 chemicals.
- ✓ Double zip and double flaps permit limited re-use if not contaminated.
- ✓ Double cuff system for good glove compatibility***.
- ✓ A comfortable garment specifically designed for ease-of-wear.



Double zip closure



Double cuff system



Also available with socks




Category III

TYPE 3-B

TYPE 4-B

TYPE 5-B

TYPE 6-B

EN 1149-5*

EN 1073-2** Class 1

EN 14126

Oil and gas

Emergency response

Industry

| | |
|---|---|
| **Reference:** | SL CHZ5 T WH 00<br>SL CHZ6 T WH 16 (WITH SOCKS****) |
| **Colour:** | White |
| **Size:** | SM to 3XL |







* Please see instructions for use for details. ** Does not protect against ionizing radiation.
*** Cuffs recommended to be taped to gloves for a tight seal. **** Size SM and size 3XL for the model with socks are MTO.

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# Tychem® 2000 C

## Comfortable, lightweight protection against biohazards and numerous inorganic chemicals.

- ✓ Protection against numerous concentrated inorganic chemicals and biohazards.
- ✓ Protective seams, stitched and over-taped with barrier-tape, providing barrier performance equal to that of the fabric.
- ✓ Double self-adhesive zipper flap offers high level of protection.
- ✓ Option: Socks attached to the ankle, to be worn inside safety boots or shoes with additional knee-length boot flap to ensure a high protection level.

Food processing* Emergency response Industry

| | |
|---|---|
| **Reference:** | TC CHA5TYL 00<br>TC CHA5TYL 16 (WITH SOCKS) |
| **Colour:** | Yellow |
| **Size:** | SM to 3XL |

*Cleaning applications. ** Does not protect against ionizing radiation.



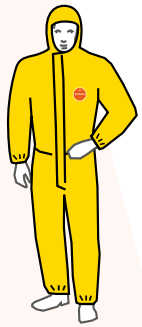
Self-adhesive zip-per and chin flap



Thumb loops



Also available with socks










Category III

TYPE 3-B

TYPE 4-B

TYPE 5-B

TYPE 6-B

EN 1149-5

EN 1073-2** Class 1

EN 14126

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# Tychem® 2000 C

## ACCESSORIES*

**Tychem® 2000 C accessories can offer enhanced protection of body parts that are more exposed to hazardous substances.**

CE Category & Type

| Category III | TYPE PB[3-B]* | EN 14126 |
|---|---|---|



### Tychem® 2000 C Gown

Knitted cuff for better comfort. Double cuffs for increased protection and tighter connection with gloves. Mandarin collar for improved neck and throat area closure.

| | |
|---|---|
| **Reference:** | TC 0290 T YL 00 |
| **Colour:** | Yellow |
| **Size**:** | SM/MD, LG/2XL and 3XL/5XL |



### Tychem® 2000 C Apron

Shin-length apron with neck and waist ties.

| | |
|---|---|
| **Reference:** | TC PA30 T YL 00 |
| **Colour:** | Yellow |
| **Size:** | One size |



### Tychem® 2000 C Sleeve

50 cm long and with wide elastics at cuffs and upper arm.

| | |
|---|---|
| **Reference:** | TC PS32 T YL 00 |
| **Colour:** | Yellow |
| **Size:** | One size |



### Tychem® 2000 C Boot cover

Knee-length overboot with slip-retardant sole. Fixation ties. Sole is partially stitched: splash-resistant, not fully liquid tight.

| | |
|---|---|
| **Reference:** | TC POBA S YL 00 |
| **Colour:** | Yellow |
| **Size:** | One size |

* Partial body protection. ** Size 3XL/5XL is MTO.

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DUPONT™

# Tyvek®

## Garments & Accessories




Back to summary

# Tyvek® 800 J

## The breathable Type 3 garment for protection against water-based inorganic chemicals under pressure.

- ✓ An effective barrier against many low-concentration, water-based inorganic chemicals (even under pressure), small-sized hazardous particles as well as oil repellent.
- ✓ Bright, over-taped seams aid wearer identification.
- ✓ Soft and lightweight fabric that is permeable to both air and water vapour.
- ✓ Ergonomic fit consistent with the shape and movement of the user.

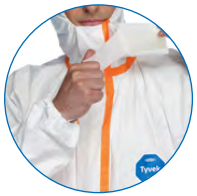
Liquid protection and/or oil repellency

Petrochemical installations

Maintenance operations

| | |
|---|---|
| **Reference:** | TJ 0198 T WH PI |
| **Colour:** | White |
| **Size:** | SM to 7XL (SIZES 4XL TO 7XL ARE MTO) |

MTO = Made to order. * Does not protect against ionizing radiation.



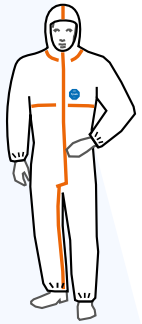
Self-adhesive chin flap



Elasticated waist



Thumb loops





Category III

TYPE 3-B

TYPE 4-B

TYPE 5-B

TYPE 6-B

EN 1149-5

EN 1073-2* Class 2

EN 14126

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# Tyvek® 600 Plus

## Combining Type 4 performance with the durability, protection and comfort of a Tyvek® garment.

- ✓ Combines performance of a Type 4 with the comfort of a nonwoven suit.
- ✓ Stitched and overtaped seams, offering equal barrier as fabric.
- ✓ Hood shape and elastic around hood are designed for a tight fit around full face respirator.
- ✓ Tunnelled elastics, cuff, ankles and face help to reduce the risk of contamination.

Nuclear industry | Medical applications* | Biological hazards | Agriculture

| | |
|---|---|
| **Reference:** | TY CHA5 T WH 00<br>TY CHA5 T WH 16 (WITH SOCKS)<br>TY CHA5 T GR 00 |
| **Colour:** | White or green |
| **Size:** | XS to 7XL<br>(WHITE - SIZES XS AND 4XL TO 7XL ARE MTO)<br>(WHITE WITH SOCKS - SIZES XS AND 4XL TO 7XL ARE MTO)<br>(GREEN - SIZES XS, SM, MD & 3XL TO 7XL ARE MTO) |

MTO = Made to order. * Follow local medical device regulations.
** Not applicable to green model. *** Does not protect from ionizing radiation.



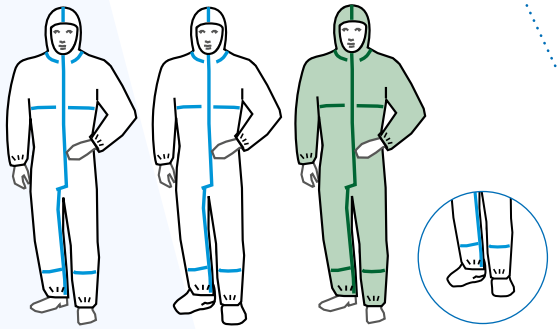
Elasticated waist



Thumb loops



Also available with socks





Category III

TYPE 4-B

TYPE 5-B

TYPE 6-B

EN 1149-5**

EN 1073-2*** Class 2

EN 14126

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# Tyvek® 500 Labo

## Protecting wearers and processes in laboratories and clean environments.

- ✓ Helps protect you and your processes in laboratories and the pharmaceutical industry.
- ✓ Innovative “feel good effect” shape for greater comfort and flexibility.
- ✓ Extremely high garment production quality control specifications.



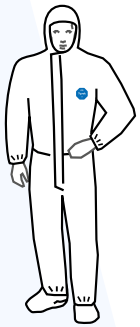
3-piece hood

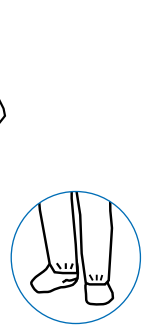


Slip-retardant soles



Attached overshoes







Pharmaceutical*

Laboratories, cosmetics

Optical and electronics

| | |
|---|---|
| **Reference:** | TY CHF7 S WH 00 |
| **Colour:** | White |
| **Size:** | SM to 3XL |

Category III

TYPE 5-B

TYPE 6-B

EN 1149-5**

EN 1073-2*** Class 2

EN 14126

* Hazardous powders & cytostatic chemicals. ** Please see instructions for use for details.
*** Does not protect from ionizing radiation.

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# Tyvek® 500 Xpert

## Setting a new standard of protection in the Type 5 and 6 category through greater protection and comfort.

ALSO AVAILABLE IN A SUSTAINABLE PACKAGING OPTION ECO PACK

- ✓ High liquid and particulate protection.
- ✓ Exceptional design and comfort.
- ✓ Good breathability thanks to air and moisture vapour permeability.
- ✓ Overall ergonomic shape for ideal fit and protection when moving.



Good hood fit



Long zipper puller



Ergonomic shape




Category III

TYPE 5-B

TYPE 6-B

EN 1149-5**

EN 1073-2*** Class 2

EN 14126

Oil and gas | Maintenance operations | Paint spraying | Pharmaceutical* | Chemical processing

| | |
|---|---|
| **Reference:** | TY CHF5 S WH XP<br>TY CHF5 S GR 00<br>TY CHF5 S BU 00 |
| **Colour:** | White, green or blue |
| **Size:** | White: SM-7XL (SIZES 4XL TO 7XL ARE MTO)<br>Green or Blue: SM-3XL (SIZES SM AND 3XL ARE MTO) |



MTO = Made to order. * Hazardous powders & cytostatic chemicals. ** Not applicable to green model. *** Does not protect from ionizing radiation.

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# Tyvek® 500 HP

NEW

## MODEL TY178

**The new Tyvek® 500 HP is designed to provide an enhanced barrier function to help protect the full-body harness and its wearer against external chemical threats*!**

Patent pending

- ✓ **Wearer & harness protection** at the same time:
  - helps to preserve the longevity of the full-body harness while working in hazardous conditions* for the wearer.
- ✓ **Unique & innovative design** with off-centered zipper entry and 4 D-Ring connection options on the garment:
  - compatible with variety of full-body harness models;
  - ideal for a wide range of applications requiring the protection of the harness & wearer against contamination from particles and/or liquids*.
- ✓ Design validated by a long series of **mannequin fall tests****.

Cleaning at heights

Painting at heights

Maintenance at heights

| | |
|---|---|
| **Reference:** | TY 178 S HP |
| **Colour:** | White |
| **Size:** | SM to 5XL (SIZES 4XL AND 5XL ARE MTO) |

MTO = Made to order. *The user must ensure the garment is suitable for the chemical hazard before use. Please refer to chemical permeation data & CE certification available in SafeSPEC™ to help you determine the level of protection needed. **Test concluding that wearing this garment over the full-body harness is not anticipated to affect the dynamic fall test performance of the full-body harness.
*** Does not protect from ionizing radiation.



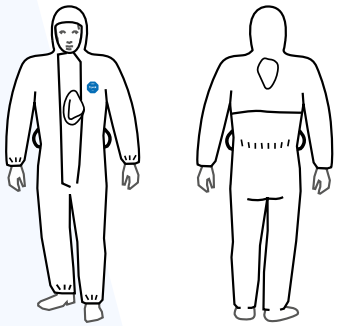
Back D-Ring sleeve



Front D-Ring sleeve



Side D-Ring sleeves





Category III

TYPE 5-B

TYPE 6-B

EN 1149-5

EN 1073-2*** Class 2

EN 14126

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# Tyvek® 500 HP

## MODEL TY198

### Solution for wearers needing chemical protection when working at heights.

- ✓ **Protection of your fall arrest equipment** / lanyard worn underneath while protecting the wearer at the same time thanks to the back pass-thru system and the hook & loop closure at the end.
- ✓ **Protection of the worker** thanks to the tight design through sealable chin flap & zipper flap, elasticated cuffs with thumb loops and snap closure system for the pass-thru.
- ✓ Design validated by a long series of mannequin fall tests.
- ✓ **High level of comfort and mobility** due to extremely light weight and the breathability of the Tyvek® fabric.
- ✓ **Superior chemical protection and durability** thanks to the unique Tyvek® fabric.
- ✓ **Free of silicone**, oil, grease, contaminates, foreign materials and surface irregularities (suitable for paint applications).

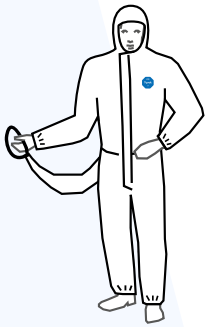
Cleaning at heights (facades, tanks, sewages)

Painting at heights (aircrafts, trains)

Maintenance at heights (asbestos removal, cleaning)

| | |
|---|---|
| **Reference:** | TY 198 S WH HP |
| **Colour:** | White |
| **Size:** | SM to 3XL (ALL SIZES ARE MTO) |

MTO = Made to order. * Does not protect from ionizing radiation.





2-piece hood for good fit around respirator



Pass-thru system



Snap closure for full tightness when pass-thru is not used



Hook and loop closure when connecting to the carabiner



Category III

TYPE 5-B

TYPE 6-B

EN 1149-5

EN 1073-2* Class 2

EN 14126

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# Tyvek® 500 Industry

## Protection for workers, and their products, in sensitive industrial environments.

- ✓ Helps to protect processes and products against human contamination.
- ✓ Tyvek® zipper and zipper flap for increased wearer and process protection.
- ✓ Internal stitched seams for enhanced process protection.



Collar



Elasticated waist



Elasticated wrists and ankles



Category III

TYPE 5

TYPE 6

EN 1149-5

EN 1073-2** Class 1

Pharmaceutical*

Biotech and electronic settings

Microbiological contamination control



| | |
|---|---|
| **Reference:** | TY CCF5 S WH 00 |
| **Colour:** | White |
| **Size:** | SM to 3XL |

* Hazardous powders & cytostatic chemicals. ** Does not protect from ionizing radiation.

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# Tyvek® 500 HV

## High visibility that doesn't wash out!

- ✓ High visibility that doesn't wash out: no laundry, no effect on colour, no need to monitor it.
- ✓ All-in-one solution: high-visibility (to the highest class), chemical, biological and antistatic protections in one coverall.
- ✓ Can replace your reusable high visibility clothing.
- ✓ Durability & breathability of Tyvek®.
- ✓ Ideal when working in dangerous environments, darkness or poor weather conditions.

High visibility | Waste handling | Rail industry, undergrounds | Construction

| | |
|---|---|
| **Reference:** | TY 125 S HV 00 |
| **Colour:** | Fluorescent Orange with silver grey retro-reflective bands |
| **Size:** | SM to 3XL |



Collar



Fluorescent orange for day visibility



Retro-reflective bands for night visibility





Category III

EN ISO 20471 RIS-3279-TOM-1*

TYPE 5-B

TYPE 6-B

EN 1149-5

EN 1073-2** Class 1

EN 14126

* High Visibility Clothing. RIS-3279-TOM Issue 1 (replaces GO/RT 3279 Issue 8).
** Does not protect against ionizing radiation.

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# Tyvek® 400 Dual TG NEW

## Protection from head to toe & fingertips!

- ✓ An innovative protective coverall that provides a protection from head to toe and fingertips thanks to the attached undergloves and socks.
- ✓ Combining Tyvek® fabric on the front with an SMS back panel, is designed for specific applications that demand comfort while providing protection from frontal exposure against elevated particles and liquids.
- ✓ This coverall is permeable to both air and water vapor yet repels water-based liquids and aerosols.
- ✓ It is very-low-linting and antistatically treated.

Chemical handling* & EV battery manufacturing

Paint spraying

Pharmaceutical**

Work involving fine hazardous particles or composite materials

| | |
|---|---|
| **Reference:** | TD 148 S WH TG |
| **Colour:** | White |
| **Size:** | SM to 3XL (ALL SIZES ARE MTO) |

* The user must ensure suitable reagent to garment compatibility before use. Please refer to chemical permeation data available in SafeSPEC™ to determine the level of protection needed.
** Hazardous powders & cytostatic chemicals.





Chin flap with adhesive tape



Tyvek® zipper



Stitched & taped seams on the underarms and wrists



Attached Tyvek® undergloves



Breathable SMS back panels



Attached Tyvek® socks



Category III



TYPE 5



TYPE 6



EN 1149-5



EN 1073-2 Class 1

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# Tyvek® 400 Dual

## Protection and durability in the front breathability in the back.

- ✓ Tyvek® protection where you need it most.
- ✓ Large breathable SMS back panel from head to ankle for increased comfort.
- ✓ External stitched seams for enhanced protection against penetration from the outside to the inside of the garment.



3 piece hood



SMS back panel



Elasticated waist



Category III

TYPE 5

TYPE 6

EN 1149-5

EN 1073-2* Class 1

Paint spraying

Work involving composite materials

| | |
|---|---|
| **Reference:** | TD CHF5 S WH 00 |
| **Colour:** | White |
| **Size:** | SM to 3XL |



* Does not protect from ionizing radiation.

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# Tyvek® 400 DualFinish

## Front that reduces the risk to stick or delaminate when exposed to tacky resins, comfort in the back.

- ✓ Developed with end users to answer their needs for superior frontal protection while sustaining ventilation and protection in the back.
- ✓ Frontal protection serves as an excellent barrier to tacky resins, fibres and many other hazards.
- ✓ Large breathable SMS back panel from shoulders to ankles helps ensure good protection and ventilation from heat.
- ✓ External stitched seams for enhanced protection against penetration from the outside to the inside of the garment.

Paint spraying

Work involving composite materials

| | |
|---|---|
| **Reference:** | TD 0127S WH 00 |
| **Colour:** | White |
| **Size:** | SM to 4XL |



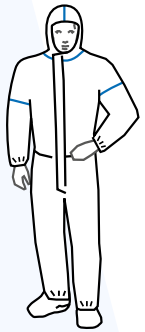
Hood



SMS back panel



Thumb-loop





Category III

TYPE 5

TYPE 6

EN 1149-5

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# Tyvek® 400 DualCombi

## For environments where comfort is important and exposure risk limited to front.

- ✓ Developed with end users to answer their needs for superior frontal protection while sustaining high ventilation and breathability in the back.
- ✓ Frontal protection serves as an excellent barrier to tacky resins, fibres and many other hazards.
- ✓ Breathable back panel from shoulders to ankles ensures ventilation and protects from excessive body heat.



Collar



Polyprop back panel



Thumb-loop





Category III




TYPE PB[6]*



Paint spraying



Work involving composite materials

| | |
|---|---|
| **Reference:** | TD 0125 S WH 00 |
| **Colour:** | White |
| **Size:** | SM to 4XL |



* Partial Body Protection.

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# Tyvek® 200 EasySafe

## Great breathability and optimised protection for less demanding applications.

- ✓ Based on an optimised polyethylene nonwoven fabric.
- ✓ Soft touch fabric for wearer comfort.
- ✓ Optimised design and packaging.



Good hood fit



Yellow stitched seams



Elasticated waist



Category III

TYPE 5

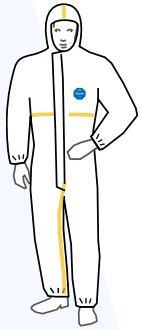
TYPE 6

EN 1149-5

EN 1073-2* Class 1

Remediation

Industrial cleaning and general manufacturing



| | |
|---|---|
| **Reference:** | TS CHF5 S WH DE |
| **Colour:** | White |
| **Size:** | SM to 3XL |

* Does not protect against ionizing radiation.

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# Tyvek® 500

## ACCESSORIES*

**Specially designed for use with Tyvek® apparel, Tyvek® 500 accessories can help offer enhanced protection for body parts that are more exposed to hazardous substances, or help protect processes from contamination.**

CE Category & Type

| Category III | TYPE PB [6-B]* | EN 14126 |
|---|---|---|



### Tyvek® 500 Labcoat with press studs and pockets

Labcoat with collar, available in white and in sizes MD to 2XL. 5 press stud closures. 3 pockets. Stitched internal seams.

| | |
|---|---|
| **Reference:** | TY PL30 S WH 00 |
| **Colour:** | White |
| **Size:** | MD to 2XL |



### Tyvek® 500 Labcoat with press studs and without pocket

Labcoat with collar, available in white and in sizes MD to 2XL. 5 press stud closures. Without pockets. Elasticated cuffs (not tunnelled). Stitched internal seams.

| | |
|---|---|
| **Reference:** | TY PL30 S WH NP |
| **Colour:** | White |
| **Size:** | MD to 2XL |



### Tyvek® 500 Labcoat with zipper and pockets

Labcoat with collar, available in white and in sizes SM to 2XL. Zipper closure. 2 pockets. Elasticated cuffs (tunnelled). Stitched internal seams.

| | |
|---|---|
| **Reference:** | TY PL30 S WH 09 |
| **Colour:** | White |
| **Size:** | SM to 2XL |



### Tyvek® 500 Labcoat with zipper and without pocket

Labcoat with collar, available in white and in sizes SM to 2XL. Zipper closure. Without pocket. Elasticated cuffs (tunnelled). Stitched internal seams.

| | |
|---|---|
| **Reference:** | TY PL39 S WH NP |
| **Colour:** | White |
| **Size:** | SM to 2XL |

All Tyvek® 500 accessories are supplied with an antistatic treatment. * Partial body protection.

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# Tyvek® 500

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CE Category & Type



Category III




TYPE PB [6-B]*



EN 14126



### Tyvek® 500 Apron

Shin-length apron with neck and waist ties. Available in white and in one size (length 108 cm).

| | |
|---|---|
| **Reference:** | TY PA30 S WH L0 |
| **Colour:** | White |
| **Size:** | One size |



### Tyvek® 500 Jacket

Hooded jacket available in white and in sizes MD to 2XL. Zipper closure. Stitched internal seams.

| | |
|---|---|
| **Reference:** | TY PP33 S WH 00 |
| **Colour:** | White |
| **Size:** | MD to 2XL |



### Tyvek® 500 Trousers

Trousers available in white and in sizes MD to 2XL. Without pockets. Elasticated waist, no elastic at ankles. Stitched internal seams.

| | |
|---|---|
| **Reference:** | TY PT31 S WH L0 |
| **Colour:** | White |
| **Size:** | MD to 2XL |



### Tyvek® 500 Hood

Hood with flange and elasticated face and neck. Available in white and in one size.

| | |
|---|---|
| **Reference:** | TY PH30 S WH L0 |
| **Colour:** | White |
| **Size:** | One size |

All Tyvek® 500 accessories are supplied with an antistatic treatment. * Partial body protection.

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# Tyvek® 500
## ACCESSORIES*

**CE Category & Type**

Category III | TYPE PB [6-B]* | EN 14126



### Tyvek® 500 Sleeve

50 cm long sleeve available in white and in one size. Adjustable arm opening. Stitched internal seams. Upper-arm in blue-coloured thread for identification purposes.

| | |
|---|---|
| **Reference:** | TY PS32 S WH LA |
| **Colour:** | White |
| **Size:** | One size |



### Tyvek® 500 Boot cover

Knee-length overboot available in white and in one size. Elasticated top and fixation ties. Stitched internal seams.

| | |
|---|---|
| **Reference:** | TY POB0 S WH 00 |
| **Colour:** | White |
| **Size:** | One size |



### Tyvek® 500 Boot cover with antislip

Knee-length overboot available in white and in one size. Elasticated top and fixation ties. Stitched internal seams. Slip-retardant sole.

| | |
|---|---|
| **Reference:** | TY POBA S WH 00 |
| **Colour:** | White |
| **Size:** | One size |



### Tyvek® 500 Shoe cover

Shoe cover available in white and in one size (38 cm long). Elasticated ankle. Stitched internal seams.

| | |
|---|---|
| **Reference:** | TY POS0 S WH 00 |
| **Colour:** | White |
| **Size:** | One size |

All Tyvek® 500 accessories are supplied with an antistatic treatment. * Partial body protection.

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# Tyvek® 500
## ACCESSORIES*



### Tyvek® 500 Shoe cover with antislip

Shoe cover available in white and in sizes 36 to 42 and 42 to 46. Elasticated ankle. Stitched internal seams. Slip-retardant sole.

| | |
|---|---|
| **Reference:** | TY POSA S WH 00 |
| **Colour:** | White |
| **Size:** | 36 to 42 & 42 to 46 |

All Tyvek® 500 accessories are supplied with an antistatic treatment. * Partial body protection.




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DUPONT™

# Tyvek®

## IsoClean®

## Garments & Accessories



Back to summary

# Controlled environments apparel selection guide

When it comes to working in a broad range of controlled environments, specifiers have many product options from which to select. The process to understand which option matches a given environment can be confusing. DuPont has tried to help reduce some of that burden by providing a complete line of products and information to help guide specifiers through their selection process. To get the most out of your cleanroom apparel, it is necessary to understand where each product can be used. To provide a quicker overview of our products and where they are intended for use, we developed the simple guide. Our goal is to provide the appropriate DuPont product that is suitable for a given environment or hazard.

## FABRIC PERFORMANCE FEATURES

COMPARISON WITHIN THE DUPONT PORTFOLIO:

● Best ◐ Good (Blank) Not recommended

| Fabric | Tyvek® IsoClean®, clean-processed and sterile | Tyvek® IsoClean®, sterile | Tyvek® IsoClean®, non-sterile |
|---|---|---|---|
| Available Sterile | Yes<br>Option code MS and DS | Yes, Sterile<br>Option code TS and WS | No<br>Option code 00 and 0B |
| Particle Barrier | ● | ● | ● |
| Non-Hazardous Liquid Barrier | ◐ | ◐ | ◐ |
| Comfort | ◐ | ◐ | ◐ |
| Durability | ● | ● | ● |
| Static Dissipation* | | ● | ● |
| Particle Shedding and Cleanliness | ● | ◐ | ◐ |
| Strengths | Ideal combination of protection, durability, comfort and cleanliness. | Ideal combination of protection, durability, comfort and cleanliness. | Ideal combination of protection, durability, comfort and cleanliness. |

* Electrostatic discharges. Antistatic performance may be reduced for sterile products. Barrier properties may be compromised through use.

# Controlled environments apparel selection guide

COMPARISON WITHIN THE DUPONT PORTFOLIO:

● Best ◐ Good (Blank) Not recommended

| | Environments/Hazards | Tyvek® IsoClean® | | | Considerations |
|---|---|---|---|---|---|
| | | Clean-Processed and Sterile (Option code MS and DS) | Sterile (Option code TS and WS) | Non-Sterile (Option code 00 and 0B) | |
| Environments | GMP A/B, ISO 5, controlled environments* | ● | ◐ | | Tyvek® IsoClean® sterile garments offer excellent cleanliness, barrier and sterility assurance level. |
| Environments | GMP C/D, ISO 6-9, controlled environments* | | | ● | Tyvek® provides an inherent particle barrier and durability, and is low linting. Clean-processing and bound seams should be considered for more critical environments. |
| Hazards | Non-hazardous, dry particles | ● | ● | ● | Tyvek® provides an inherent barrier against small particles. Bound seam garments offer a higher level of protection than serged seam garments. |
| Hazards | Hazardous powders Notice: DuPont Controlled Environments garments should not be used in potentially explosive or flammable environments. | ● | ● | ● | Use bound seamed garments when working with hazardous powders. |
| Hazards | Hazardous liquid splash Examples: organic solvents, caustics | | | | Please refer to our Tychem® product line for liquid and vapor chemical protection. |

* Tyvek® IsoClean® (Option Code DS and MS) garments are most typically considered for use in GMP A-D, ISO Class 5-8. However, use in ISO Class 4 and 9 environments may also be considered depending on the needs of a particular application. In all cases, garment choice depends on evaluation of, among other attributes, garment design and processing, as well as the needs of specific applications. Clean-processed and bound seam garments offer the highest level of contamination control and should be used in more critical applications. Sterile garments are available if required. It is the end-user's responsibility to determine the appropriate garment for a given application.

# Tyvek® IsoClean®

## CLEAN AND STERILE COVERALL IC 193 B DS STERILE COVERALL IC 193 B TS

### Coverall with attached hood and overboots

- ✓ Sterility Assurance Level (SAL) of $10^{-6}$ (ISO 11137).
- ✓ Helmke Drum Cat. 1 (IEST-RP-CC003.3) only for IC 193 DS.
- ✓ Dual barrier validated packaging system (option DS) for contamination control and sterility risk management.
- ✓ Packed in an ISO Class 4 Certified Cleanroom.
- ✓ Internal bound seams covered with garment fabric to reinforce seam protection and reduce potential for liquid and particle penetration.
- ✓ The hood fits a sterile mask and has attached ties.

Biotechnology | Pharmaceutical* | Medical device manufacturing

| | |
|---|---|
| **Reference:** | IC 193 B WH DS<br>IC 193 B WH TS |
| **Colour:** | White |
| **Size:** | XS to 7XL |

* Hazardous powders & cytostatic chemicals.



Integrated hood with ties



Zipper closure with storm flap



Integrated overboots with Gripper™ sole





Category III

TYPE 5-B

TYPE 6-B

EN 1073-2* Class 2

EN 14126

ISO 11137

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# Tyvek® IsoClean®

## CLEAN AND STERILE COVERALL IC 183 B DS STERILE COVERALL IC 183 B TS

### Unhooded coverall

- ✓ Sterility Assurance Level (SAL) of $10^{-6}$ (ISO 11137).
- ✓ Helmke Drum Cat. 1 (IEST-RP-CC003.3) only for IC 183 DS.
- ✓ Dual barrier validated packaging system (option DS) for contamination control and sterility risk management.
- ✓ Packed in an ISO Class 4 Certified Cleanroom.
- ✓ Internal bound seams covered with garment fabric to reinforce seam protection and help reduce potential for liquid and particle penetration.

Clean-processed and sterile

Medical device manufacturing

Pharmaceutical*

| | |
|---|---|
| **Reference:** | IC 183 B WH DS<br>IC 183 B WH TS |
| **Colour:** | White |
| **Size:** | SM to 3XL |





Bound neck



Waist elastication



Tyvek® covered thumb loops



Category III

TYPE 5-B

TYPE 6-B

EN 1073-2** Class 2

EN 14126

ISO 11137

* Hazardous powders & cytostatic chemicals. ** Does not protect from ionizing radiation.

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# Tyvek® IsoClean®

## CLEAN AND STERILE ACCESSORIES* OPTION MS
## STERILE ACCESSORIES* OPTION WS

Type

TYPE PB [6-B]*

EN 14126

CAT 1

Category I



### Tyvek® IsoClean® Labcoat with bound neck - model IC 270 B

Labcoat available in white in sizes SM to 3XL. Bound seams. Covered elastication at wrists. Front snap closure for easy donning and doffing. Packed in a dual barrier validated packaging system (double bagged).

| | |
|---|---|
| **Reference:** | IC 270 B WH MS<br>IC 270 B WH WS |
| **Colour:** | White |
| **Size:** | SM to 3XL |

Category III



### Tyvek® IsoClean® Sleeve - model IC 501 B

Sleeve available in white and in one size. Bound seams. Tunnelled elastication at wrist and bicep. Packed in a dual barrier validated packaging system (double bagged).

| | |
|---|---|
| **Reference:** | IC 501 B WH MS<br>IC 501 B WH WS |
| **Colour:** | White |
| **Size:** | One size |

Category III



### Tyvek® IsoClean® Boot cover - model IC 458 B

Boot cover available in white, in sizes SM to XL. Bound seams. Covered elasticated leg opening. Ankle ties. Slip-retardant Gripper™ sole. 18" (45.7 cm) high. Packed in a dual barrier validated packaging system (double bagged).

SM: 10" fits up to UK men's size 4.5/EU 37; MD: 12" fits up to UK men's size 6 1/2/EU 39.5; LG: 14" fits up to UK men's size 131/2/EU 48.5; XL: 16" Fits up to UK men's size 18 1/2/EU 53

| | |
|---|---|
| **Reference:** | IC 458 B WH MS<br>IC 458 B WH WS |
| **Colour:** | White |
| **Size:** | SM to XL |

Category III



### Tyvek® IsoClean® Hood with ties - model IC 668 B

Hood available in white and in one size. Bound seams. Bound hood opening. Full face opening. Ties with loops for adjustable fit. Packed in a dual barrier validated packaging system (double bagged).

| | |
|---|---|
| **Reference:** | IC 668 B WH MS |
| **Colour:** | White |
| **Size:** | One size |

N/A = Not Applicable. *Partial body protection for Cat III products.

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# Tyvek® IsoClean®

## CLEAN AND STERILE ACCESSORIES* OPTION MS
## STERILE ACCESSORIES* OPTION WS

CAT 1

Category I



### Tyvek® IsoClean® Hood and mask - model IC 982 B

HOOD: Bound internal seams. Bound head opening. Ties with loops for adjustable fit. Clean and sterile. MASK: Pleated polyethylene outer. 17.5 cm wide. Sterile. Blue. Items packed in a dual barrier validated packaging system (double bagged).

| | |
|---|---|
| **Reference:** | IC 982 B WH MS |
| **Colour:** | White |
| **Size:** | One size |

CAT 1

Category I



### Tyvek® IsoClean® Bouffant - model IC 729 WH

Bouffant available in white and in one size. Elastic headband. Packed in a dual barrier validated packaging system (double bagged).

| | |
|---|---|
| **Reference:** | IC 729 S WH MS<br>IC 729 S WH WS |
| **Colour:** | White |
| **Size:** | One size |

N/A = Not Applicable.



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# Tyvek® IsoClean®

## STERILE

### Tyvek® IsoClean® Hood with attached mask and ties IC 689 B WS

✓ Hood with attached mask* and ties for adjustable fit in the chest area. Available in white and in one size. Gamma-sterilized and double bagged. Bound internal seams. Bound face opening for low particle shedding. Aseptically folded.



Category III | TYPE PB[6-B]** | EN 14126

| | |
|---|---|
| **Reference:** | IC 689 B WH WS |
| **Colour:** | White |
| **Size:** | One size |

* The attached mask is a blue sterile cleanroom mask made out of pleated polyethylene outer layer having a width of 17.5 cm. Please note that it is not a PPE (e.g. not an FFP1,2 or 3) mask. ** Partial body protection.

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# Tyvek® IsoClean®

## NON-STERILE ACCESSORIES*

Type

Category III | TYPE PB [6-B]* | EN 14126



### Tyvek® IsoClean® Labcoat with bound neck - model IC 270 B option 0B

Labcoat available in white in sizes SM to 3XL. Bound seams. Covered elastication at wrists. Front snap closure for easy donning and doffing. White.

| | |
|---|---|
| **Reference:** | IC 270 B WH 0B |
| **Colour:** | White |
| **Size:** | SM to 3XL |



### Tyvek® IsoClean® Gown - model IC 702 S option 00

Gown available in white and in sizes SM/MD and LG/2XL. Serged seams. Bound neck with ties. Knitted cuffs.

Bound ties originating at center front waist.

| | |
|---|---|
| **Reference:** | IC 702 S WH 00 |
| **Colour:** | White |
| **Size:** | SM/MD and LG/2XL |



### Tyvek® IsoClean® Sleeve - model IC 501 B option 00

Sleeve available in white and in one size. Bound seams. Covered elastic at both ends. 45 cm long.

| | |
|---|---|
| **Reference:** | IC 501 B WH 00 |
| **Colour:** | White |
| **Size:** | One size |



### Tyvek® IsoClean® Shoe cover - model IC 451 S WH option 00

Shoe cover available in white and in sizes MD and LG. Fixation ties. Gripper™ sole. Stitched seams. MD: 11.75″ fits up to UK men's size 6 1/2/EU 39.5; LG: 14″ fits up to UK men's size 12 1/2/EU 47

| | |
|---|---|
| **Reference:** | IC 451 S WH 00 |
| **Colour:** | White |
| **Size:** | MD and LG |

N/A = Not Applicable. *Partial body protection.

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# Tyvek® IsoClean®

## NON-STERILE ACCESSORIES*

Type

Category III | TYPE PB [6-B]* | EN 14126



### Tyvek® IsoClean® Boot cover - model IC 458 B WH option 00

Boot cover available in white and in sizes MD and LG. Fixation ties. Gripper™ sole. Bound seams. MD: 12″ fits up to UK men's size 6 1/2/EU 39.5; LG: 14″ fits up to UK men's size 131/2/EU 48.5

| | |
|---|---|
| **Reference:** | IC 458 B WH 00 |
| **Colour:** | White |
| **Size:** | MD and LG |



### Tyvek® IsoClean® Chemo gown model IC 703 S option 00

Collared gown with hook and loop closure in the neck. Increased skirt length ensures protection against frontal exposure. Openness in the back closure increases wearer comfort. Serged seams. Knit cuffs. Bound ties at waist originating from elasticated sides.

| | |
|---|---|
| **Reference:** | IC 703 S WH 00 |
| **Colour:** | White |
| **Size:** | XS – 3XL<br>FOR A BETTER FIT |



### Tyvek® IsoClean® Hood with ties - model IC 668 B option 00

Hood available in white and in one size. Bound seams. Bound hood opening. Full face opening. Ties with loops for adjustable fit.

| | |
|---|---|
| **Reference:** | IC 668 B WH 00 |
| **Colour:** | White |
| **Size:** | One size |



### Tyvek® IsoClean® Bouffant - model IC 729 S option 00

Bouffant available in white and in one size. Serged seams. Elastic headband. 54 cm diameter.

| | |
|---|---|
| **Reference:** | IC 729 S WH 00 |
| **Colour:** | White |
| **Size:** | One size |

N/A = Not Applicable. * Partial body protection.

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DUPONT™

# Tyvek®

## Garments & Accessories for Emergency Services



Back to summary

# Tyvek® 800 ES

NEW

## The new Type 3 Tyvek® garment with improved breathability for longer wear time, ideal for delivering health care in high-risk situations.

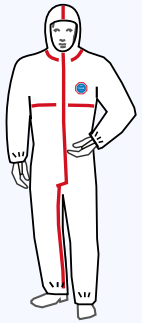
- ✓ An effective biological barrier including virus protection ISO 16604 class 5, and performant in context of Biohazard Risk Group 3 / BSL3* or higher (Tuberculosis, Covid...) with high exposure to body fluids.
- ✓ Improved breathability measure: **20< Ret<25 m²Pa/W**.
- ✓ Red over-taped seams help identify the emergency responder.
- ✓ Pass EN 13795-1 High Performance requirements used in medical device applications.

Emergency medical response

Medical applications**

Biohazards

| | |
|---|---|
| **Reference:** | TJ 198 T WH 00 25ES |
| **Colour:** | White |
| **Size:** | SM to 3XL |





Adhesive storm flap



Tyvek® zipper



Tyvek® covered thumb loops



Elasticated waist



Elasticated ankles



Category III

TYPE 3-B

TYPE 4-B

TYPE 5-B

TYPE 6-B

EN 1149-5

EN 14126

EN 13795-1 Surgical clothing and drapes

* BSL: Biosafety Level. **Follow local medical device regulations.

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# Tyvek® 500 AV

NEW

## The first of its kind Type 5 & 6 garment with an Anti-Viral functionality for maximal infection control, reducing patient risk of cross contamination in medical settings.

- ✓ The Anti-Viral functionality adds a new layer of protection to eliminate the virus or bacteria upon contact with the garment.
- ✓ Ideal for routine tasks in low-risk situations, or when risk is defined. Context of Biohazard Risk Group 3 / BSL3* or less with low exposure to body fluids.
- ✓ Breathability measure: **13<Ret<20 m²Pa/W**.
- ✓ Pass EN 13795-1 Standard Performance requirements used in medical device applications.

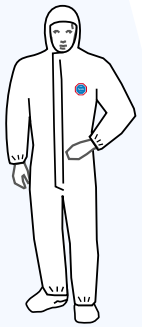
Emergency medical response

Medical applications**

Biohazards

Microbiological contamination control

| | |
|---|---|
| **Reference:** | TY 198 S WH 00 25AV |
| **Colour:** | White |
| **Size:** | SM to 3XL |





Good hood fit



Tyvek® zipper



Elasticated wrists



Elasticated waist



Elasticated ankles



Category III

TYPE 5-B

TYPE 6-B

EN 1149-5

EN 14126

ISO 18184 SARS Cov2

EN 13795-1 Surgical clothing and drapes

* BSL: Biosafety Level. **Follow local medical device regulations.

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# Tyvek® 500 ES

NEW

## The new Tyvek® 500 ES coverall offers the best breathability you can get for the level of Biological protection.

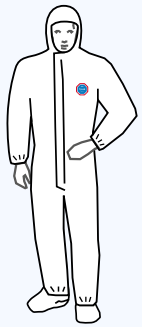
- ✓ Type 5 & 6 coverall including virus protection ISO 16604 class 2.
- ✓ Optimal protection for low-risk situations, in a context of Biohazard Risk Group 3 / BSL3* or less with low exposure to body fluids.
- ✓ Breathability measure in the same category as SMS: **Ret<6 m²Pa/W**.
- ✓ Demonstrated improved comfort in sweating hot plate, sweating mannequin.
- ✓ Pass EN 13795-1 requirements used in medical device applications.

Emergency medical response

Medical applications**

Biohazards

| | |
|---|---|
| **Reference:** | TY 198 S WH 00 25ES |
| **Colour:** | White |
| **Size:** | SM to 3XL |





Good hood fit



Tyvek® zipper



Elasticated wrists



Elasticated waist



Elasticated ankles



Category III

TYPE 5-B

TYPE 6-B

EN 1149-5

EN 14126

EN 13795-1 Surgical clothing and drapes

* BSL: Biosafety Level. **Follow local medical device regulations.

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# Tyvek® 500 ES Gown NEW

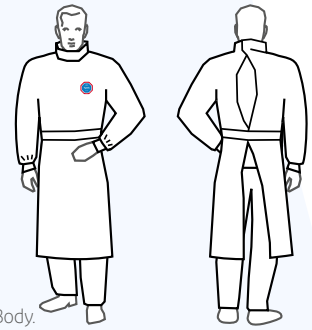
**A new gown with enhanced comfort, offers the breathability of medical clothing with the biological protection of a PPE, protecting both the wearer and the patient from biological risks.**

- ✓ Type 6 [PB] gown including virus protection ISO 16604 class 2.
- ✓ Efficient protection for low-risk situations, in a context of Biohazard Risk Group 3 / BSL3* or less with low exposure to body fluids.
- ✓ Breathability measure in the same category as SMS: **Ret<6 m²Pa/W**.
- ✓ Pass EN 13795-1 requirements used in medical device applications.

Medical applications**

Biohazards

| | |
|---|---|
| **Reference:** | TY 703 S WH 00 30ES |
| **Colour:** | White |
| **Size:** | SM to 3XL |





Collar





Knit cuffsfor added comfort under the glove



Ties in the front



Open back



Category III

Type PB[6-B]***

EN 1149-5

EN 14126

EN 13795-1 Surgical clothing and drapes

* BSL: Biosafety Level. **Follow local medical device regulations. *** PB: Partial Body.

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DUPONT™

# ProShield®

## Garments




Back to summary

# ProShield® 60

## Best in class microporous film at a highly economical price.

- ✓ New pattern for a better fit.
- ✓ Good liquid repellency.
- ✓ Protection against low-medium concentrated water-based chemicals.
- ✓ Low air permeation versus Tyvek®.







Elasticated hood, waist, wrists and ankles



Storm flap



3-piece crotch area



Category III

TYPE 5

TYPE 6

EN 1149-5

EN 1073-2* Class 1

General maintenance

Industry

| | |
|---|---|
| **Reference:** | P6 127 S WH 00 |
| **Colour:** | White |
| **Size:** | SM to 7XL (4XL TO 7XL ARE MTO) |



MTO = Made To Order. * Does not protect from ionizing radiation.

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# ProShield® 20 SFR

## The solution to protect you and your flame-resistant workwear underneath.

- ✓ Maximising wearer comfort: thanks to the open structure of its breathable non-woven SMS fabric.
- ✓ Non-halogenated flame-retardant non-woven fabric, free of substances of very high concern to be compliant with REACH regulations.
- ✓ Antistatic treatment on both sides***.



3 piece hood



Elasticated wrists



Elasticated waist



Category III

TYPE 5

TYPE 6

EN 1149-5

EN 1073-2* Class 1

EN ISO 14116** Index 1

Petrochemical industries

Metal grinding, gas and metal applications

Railway

| | |
|---|---|
| **Reference:** | F1 CHF5 S WH 00 |
| **Colour:** | White with orange seams*** |
| **Size:** | MD to 3XL |



* Does not protect from ionizing radiation.
** EN ISO 14116:2008 requires a tensile strength of >150 N. This garment has a tensile strength of >30 N only.
*** Test conducted on certain FR fabrics and FR garments have demonstrated that antistatic properties reduce overtime. In the interests of safety, that's why we initially limit the shelf-life for the antistatic property of ProShield® 20 SFR to 18 months.

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# ProShield® 20

**Based on an optimised SMS technology, ProShield® 20 is a breathable lightweight coverall for entry-level Type 5, 6 protection.**

- ✓ Limited particle protection.
- ✓ High comfort level: high air and water vapour permeability.
- ✓ Available in blue and white.



Elasticated hood



Elasticated wrists



Elasticated waist



Category III

TYPE 5

TYPE 6

EN 1149-5

EN 1073-2* Class 1

General maintenance

Industry

| | |
|---|---|
| **Reference:** | PB CHF5 S WH 00<br>PB CHF5 S BU 00 |
| **Colour:** | White or blue |
| **Size:** | SM to 3XL |



MTO = Made To Order. * Does not protect from ionizing radiation.

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# ProShield® 8 Proper

## Durable, washable and comfortable garment ideal for general maintenance activities.

- ✓ A versatile ultra-tough protective garment with pockets for non hazardous substances.
- ✓ Stiff, durable and dark coloured non-woven polyethylene fabric. Antistatic treated on the inside (for comfort).
- ✓ Washable up to 7 times.



Mandarin collar



Elasticated waist



Open ankles (not elasticated)



Category I

Do-it-yourself

General maintenance

Cleaning

Re-usable garment for visitors



| | |
|---|---|
| **Reference:** | TY CCF5 S GY 00 |
| **Colour:** | Grey |
| **Size:** | SM to 2XL |

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DUPONT™

Tyvek®

# Sustainability Initiatives and Recycling Programme



Back to summary

# Sustainability Initiatives in Tyvek® Protective Apparel Business



## PROTECTING PEOPLE AT WORK AND ADVANCING SUSTAINABILITY

From product development and manufacturing to packaging, distribution and marketing, we are focused on continuous innovation to advance sustainability along the value chain.

CLICK TO JUMP TO IT

**Renewable energy used during Tyvek® fabric manufacturing**

**Sustainability efforts in our protective apparel packaging**

**Tyvek® recycling programme**

# Renewable Energy Use During Tyvek® Fabric Manufacturing

SINCE 2022



Tyvek® is produced using renewable electricity in our operations. DuPont achieved this milestone by purchasing renewable energy credits (RECs) and guarantees of origin (GOs) to match the energy consumed in its 2022 operations and is committed to additional purchases annually.

This underscores the company's commitment to achieving its renewable energy goal and acting on climate stewardship as part of its 2030 Sustainability Goals.

- ✓ Reduce our Scopes 1 and 2 greenhouse gas emissions 50% by 2030 from the 2019 base year and deliver carbon neutral in operations by 2050.
- ✓ Reduce our Scope 3 emissions from purchased goods and services and end of life of sold products by 25% by 2030 from 2020 base year.
- ✓ Source 60% of power to our operations from renewable sources by 2030 as part of our RE100 commitment.

## SUSTAINABILITY EFFORTS IN OUR PROTECTIVE APPAREL PACKAGING :

# Tyvek® 500 Xpert Eco Pack packaging option

SINCE 2017

Significant reduction in consumption of packaging materials achieved during last 5 years.







Estimated avoided Environmental Impacts

(for an order of **35000** suits shipped to France)

**3 tons of $CO_2$ equivalent**

35 Paris-Toulouse Flight for one passenger

**820 kg of solid waste**

The monthly municipal solid waste generation of 21 European inhabitants

**60 $m^3$ of water**

330 baths

**77700 MJ of Primary Energy**

The primary energy demand of:

- The monthly electricity consumption of 14 European inhabitants
- 1700 kg of crude oil

*External study report on the environmental benefits of packaging reduction

## SUSTAINABILITY EFFORTS IN OUR PROTECTIVE APPAREL PACKAGING :

# Packaging with PCR content*

SINCE END OF 2023

The packaging for DuPont™ Tyvek®, Tychem® and ProShield® garments have been made with PCR (Post-Consumer Recycled) content* as of late 2023. PCR content will be gradually available in printed bags starting with some models and the transition will continue with more models through 2024.

The aim is to reduce the usage of first grade polymers and enforce the PCR raw materials. While these regulations are currently country specific, DuPont is proactively working on the application of PCR content for packaging of the chemical protective clothing range.

With this initiative and in line with our Sustainability Goals, DuPont Personal Protection contributes to the reduction of indirect GHG (Green House Gases) emissions. By purchasing these coveralls manufactured by DuPont, you will also indirectly reduce usage of virgin grade LDPE (Low Density Polyethylene) in packaging and help protecting the environment.

Additionally, we eliminated transparent outer bags used in Tychem® garment packaging which also allows the reduction of virgin polyethylene bags consumption.




*Minimum 50% PCR in packaging

# Tyvek® protective apparel recycling program*

DuPont™ Tyvek® is proud to expand our long standing Tyvek® Protective apparel recycling program to help our customers in Europe manage used Tyvek® and IsoClean® protective apparel and reduce wastage.

## Why recycle?

DuPont™ Tyvek® is made from high-density polyethylene (HDPE). For this reason, Tyvek® can be mechanically recycled into products such as underground cable protection piping, automotive parts, blown film, packaging cores and trays and in some cases back into pure polyethylene pellets.

The Tyvek® protective apparel recycling program offers the chance to divert garments away from landfills and give them a second life in products like containers, lumber pallets and park benches.

For every case of 50 Tyvek® coveralls that is recycled, 10 kgs of Tyvek® are diverted from the waste stream and given a second life in products.

## DuPont Sustainability commitment

Sustainability is at the core of what we do - from reducing our operational footprint and creating market-facing sustainable solutions to addressing the global challenges of the future. This program is yet another example of the DuPont commitment to sustainability. The Tyvek® protective apparel recycling program is easy to participate in and is a cost-effective and responsible choice.

**CONSERVE MATERIALS AND ENERGY**

**BOOST EMPLOYEE MORALE**

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# Appendices



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APPENDIX 1

# CE markings, European standards and legislative framework

## Duty of care

Employers have a Duty of Care to their employees and must take all reasonable and practicable steps to ensure the health and safety of staff in the workplace. This means that it is not sufficient to merely be in compliance with the basic health and safety legislation that is in place which might be unsuitable, inadequate or simply out of date. Employers are obligated to keep abreast with contemporary knowledge and technology and be fully conversant with potential workplace risks. Note that failure to comply with health and safety legislation can be a criminal offence and in particular, individual directors and company officers may have a personal responsibility and liability under certain national laws such as the UK Health and Safety at Work etc. Act 1974.

Regulations often impose absolute obligations on employers to put specific safety measures in place or to avoid particular hazards. As a consequence, employers are required to implement a management system for identifying and managing any exposures, or potential exposures, to risks and, in practice, this invariably means that adequate risk assessment exercises have to be carried out and documented on a periodic basis (please see Appendix 3).

## Technical standards and their limitations

Standards, particularly international standards, play a vital role in ensuring that certain agreed and minimum standards of quality, interoperability and performance are adhered to. This is in order to protect both the consumer and the environment, and to facilitate the transfer of trade and technology. However, although common standards play a huge role in the specification of protective apparel and other safety equipment, it is not possible to select protective clothing for a given hazard situation simply by relying on industry-wide standards or certifications.

This is partly due to the fact that there can be very wider anging quality and performance latitudes within a given Standard and these permitted margins can equate to big differences in product capabilities.

For example, there is a huge number of protective suits available commercially and although each may carry the European-wide CE mark, there are very wide ranging performance differences for products meeting the same certification "Type". For example for the Type 5, 80% inward leakage average results must be lower than 15% of inward leakage. The same applies to the different garment 'Classes' relating to nuclear particulate protection where the very broad performance spans of the three bands render them, at best, a very blunt instrument for evaluating the relative performance of different garments (please see Appendix 7 - Nominal Protection Factor).

From this it is easily seen that the allocation of a garment to a specific protection type does not necessarily provide an indication that all suits of this type offer the same protection. It is also important to understand that a CE mark in itself does not signify 'approval' of any kind. The former EU legislation in the form of Directive 89/686/EEC and new PPE Regulation (EU) 2016/425 make these limitations abundantly clear and in its own words says that the documents merely defines "the basic requirements to be satisfied by personal protective equipment". In other words it represents the 'bare minimum' rather than the ideal or preferred protective standard. Such standards therefore correspond to an absolute 'entry level' of garment performance and represent only a baseline, or starting point, for satisfactory garment selection. There are other limitations relating to standards which should also be understood. These include:

Standards, and international standards in particular, take a long time to develop, agree and harmonise. The requirement for lengthy consultation periods adds to the problem. The same applies to their subsequent review and revision. This means that standards tend to be quickly out of date and out of line with technological developments, modern safety criteria and the latest scientific knowledge in the market place.

Although some standards may be performance-driven, as opposed to specification-driven, and are claimed to be flexible enough to be independent of technical progress, in practice the "lowest common denominator" effect of standards can serve to mitigate against innovation and creativity. Their prescriptive nature tends to force manufacturers along set paths when there may be other options and solutions that are as good, or better than those dictated by a prescriptive standard.

- Compliance with a standard, while generally representing a minimum acceptable quality level, can confer unwarranted credibility and status to companies and products that are not necessarily of a good merit. An 'ISO' certificate, for example, is, in itself, no guarantee that a company manufactures superior quality products. It merely proves a degree of procedural compliance and this can be a misleading indicator.
- A blind adherence to standards can mitigate against the application of 'common sense' in situations where this is more appropriate.
- Due to their universality, international standards can be open to interpretation since they are enacted across many states (for example, in the case of CE marking, these apply across the entire 31 member states of the European Economic Area).
- International harmonisation results in an 'approximation' of existing national laws and can result in a dilution of some national standards which is detrimental to overall levels of safety.
- Users and specifiers can be lulled into a false sense of security by an over-reliance on published technical standards. The use of standards can lead to 'decision abrogation' and 'accountability transfer'effects due to a myopic over-reliance on the perceived safety attributes of 'certified' products.
- Compliance with standards, especially those involving inordinate amounts of paperwork or high financial outlays, can divert resources away from improving genuine quality and safety issues.
- By practical necessity, standards tend to be data-driven and based on 'recognised test methods', i.e. laboratory tests and simulations, and do not necessarily take into adequate account the real life and in-service aspects of product usage.
- Similarly, many standards are based on a necessarily limited amount of data and risk scenarios which reduces their applicability to all hazard situations.
- Standards, therefore, supplement but are no substitute for a thorough assessment of hazards and the protective options available. All this, however, is not to downgrade the importance of standards. They are absolutely vital tools in establishing minimum safety and quality performance, of ensuring product and process consistency and repeatability, and in establishing cross-industry and cross-market compatibility. It is, however essential to be aware -of their limitations and never use them as an excuse for not conducting a proper evaluation of protective garments or any other PPE.

## Mandatory Standards

EU directives such as former Council Directive 89/686/EEC[1] and new PPE Regulation (EU) 2016/425 governing personal protective equipment that is placed on the market, are required to be embraced by companies operating in EU and EEC member countries and enshrined in national law. Such legislation is designed to facilitate the free movement of goods within the Community and ensure that certain basic health and safety requirements are met to protect the end-user (the 'essential requirements').

The general scope of EU Directives/Regulations such as this tends to be wide in nature and ranges from clothing and respiratory protective masks to safety footwear and fall arrest equipment. There are only a very few exclusions to this Directive and these generally relate to specialised equipment already covered by EU legislation.

## ISO

An EN standard is essentially a regional Standard. Increasingly, however, European Standards (prefixed EN – European Norm) are being superseded, subsumed or harmonised with International Standards (prefixed ISO). ISO is the International Organization for Standardization which works to develop and translate standards at an international level. There is much co-operation and mutual adoption between ISO and the EU and mutually adopted standards bear the prefix 'EN-ISO'.

## CEN

CEN (Comité Européen de Normalisation) is the European Committee for Standardization and is the non- profit body officially vested by the EU to develop cross-border EN standards and specifications. It operates alongside the European Committee for Electrotechnical Standardization (CENELEC) and the European Telecommunications Standards Institute (ETSI) to promote and deliver harmonised standards.

## National Standards

These are the standards, such as British Standards (prefixed 'BS'), Deutsche Industrie Norms (prefixed 'DIN') or Norme Française 'NF', that prevail in individual countries. Increasingly, they are being superseded by their European equivalents, in which case they are referred to as 'BS-EN' or 'BS-EN' etc.). Similarly, a standard bearing the prefix 'BS-EN-ISO' refers to a standard containing the same core information in all cases and which has been adopted across all three territorial boundaries - a truly international standard.

## Proprietary Standards

As we have seen, and despite their limitations, legislated standards are a powerful means of ensuring wholesale compliance with minimum levels of safety, quality and uniformity. However, commercially astute, customer-focused businesses will always endeavour to aspire to technical specifications, ethical behaviour and levels of customer support that are far in excess of any legal minima. In this way they can differentiate themselves from the 'only-just-good-enough' suppliers and demonstrate their superiority.

## Notes

For Information relating to EU ATEX directives (potentially explosive atmospheres) please see Appendix 9. For a summary of the European standards for protective clothing refer to Appendix 7 from British Standards[1].

[1] HSE online, European Standards and Markings for protective clothing, Appendix 7 (United Kingdom, HSE, 2013).

## Interpretation of instructions for use and garment labels

The six Types of protection within Category III chemical protective clothing are intended to facilitate garment selection as a function of nature of the hazard exposure. Certification to a particular protection type represents the tightness of the suit against a particular form of exposure (gas, liquid or dust). However it does not mean that the suit is 100% impervious to a given type of exposure. The whole suit Type-tests merely define a maximum allowable amount of a challenge test liquid, aerosol or particulates to ingress into the garment.

For example, for the Type 5, 80% inward leakage average results must be lower than 15% of inward leakage. Allocation to a specific protection type is therefore not a sign that all protection suits of this type have the same barrier properties. Rather, protection offered by Type 5 suits can differ greatly in terms of the actual particulate barrier they provide, depending on the suit fabric, seam construction, design and whether the testing has been conducted with additional barriers, such as taping around the cuffs, ankles and hood/mask.

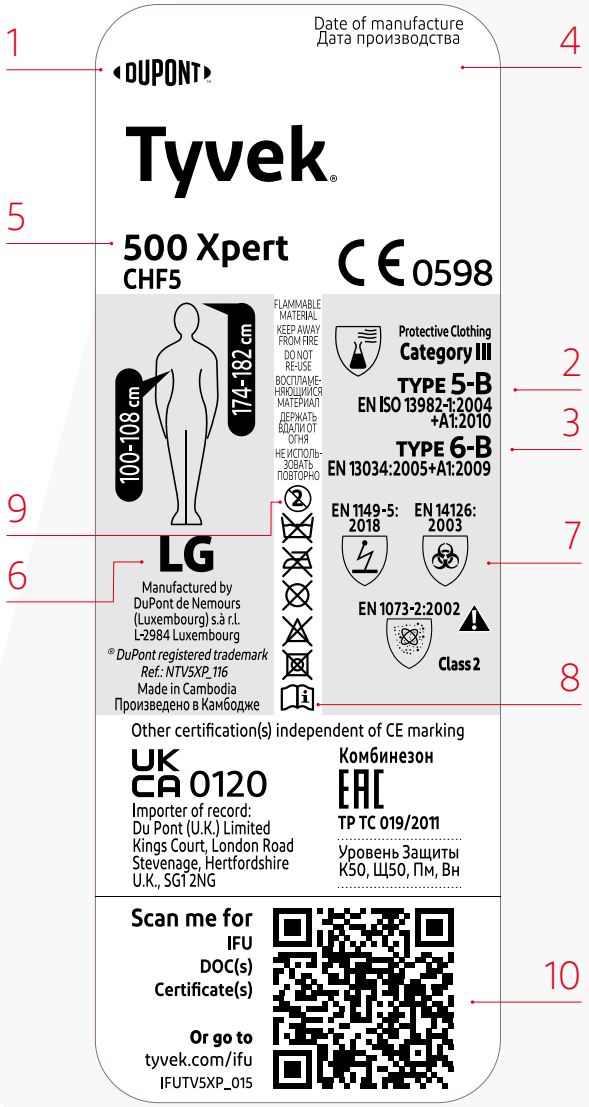
### Quality Control

All CE-certified protective clothing has a marking (e.g. product label) and is supplied with a sheet of information by the manufacturer (i.e. Instructions for Use). The content of these two items is checked and released by the notified body that issued the CE marking for the product, and therefore these are official documents. The manufacturer is under obligation to have a Quality Control in place to ensure a regular monitoring of the fabric and garment performance vs the basic health and safety requirements of the Directive / upcoming Regulation.

### Marking/labelling attached to garment

Protective clothing for chemicals shall be marked with at least the following information. The marking must be clearly visible and durable for the life of the clothing (please see an exemplary label).

1. the name, trademark or other means of identification of the manufacturer;
2. the Type classification, i.e. Type 6 for chemical splash-protective garments;
3. the number and date of publication of European Standard for the type;
4. the date of manufacture;
5. the manufacturer's type, identification or model number;
6. the size range (as defined in EN 340);
7. a pictogram showing the clothing is for protection against various hazards (here protection against infective agents);
8. a pictogram inviting to read instructions for use and any other information supplied by the manufacturer;
9. re-usable PPE to be marked with care pictograms according to ISO 3758. Limited life PPE is marked with the warning phrase 'Do not re-use' (please see also EN 340).
10. QR code to access digital IFU (Instructions For Use), Declaration(s) of Conformity and Certificate(s)



APPENDIX 2

# Protection against biological hazards

## Introduction

Strict medical infection control is essential for preventing the spread of highly infectious diseases – and it is mainly the lack of such strict control in the countries most affected by the recent Ebola outbreak that has been responsible for its severity. In countries with high standards of public healthcare, the risk of transmission is generally considered significantly lower.

The use of personal protective equipment is an essential element of infection control for people responsible for care, treatment, transport, preventive measures and decontamination, not only for their own safety, but also for that of their environment.

## Protection when handling biological agents

Whether in agriculture, the food industry, waste separation and recycling facilities, sewer systems or in the emergency services sectors, if workers come into contact with biological agents, safe and reliable protective clothing is essential to prevent infections and the spread of germs.

### What are biological agents?

A comprehensive definition can be found in EU directive 2000/54/EC referring to the protection of workers from risks related to exposure to biological agents at work.

"Biological agents" refers primarily to micro-organisms such as bacteria, viruses and fungi. According to this directive, it also refers to biological materials, including those which have been genetically modified, as well as agents. What is important is that these substances can be pathogenic, sensitising or toxic. Biological agents have the ability to adversely affect human health in a variety of ways, ranging from relatively mild allergic reactions to serious medical conditions, including death.

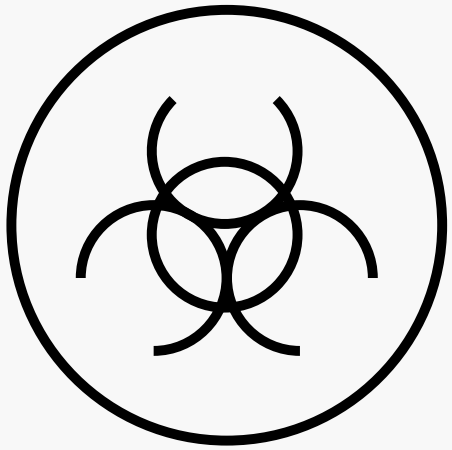
### What are the biological agent risk groups?

The aforementioned directive requires the classification of biological agents into four risk groups, according to their level of risk of infection* :

**Table 1**

| | Biohazard Risk Group 1 | Biohazard Risk Group 2 | Biohazard Risk Group 3 | Biohazard Risk Group 4 |
|---|---|---|---|---|
| **Bio Safety Level** | BSL1 | BSL2 | BSL3 | BSL4 |
| **Description** | Risk Group 1 organisms do not cause disease in healthy adult humans. | Risk Group 2 organisms can cause disease in humans, but the disease is treatable or preventable. | Risk Group 3 organisms cause serious disease in humans. Treatments and vaccines for these diseases may exist. | Risk Group 4 organisms cause deadly disease in humans, and they can easily travel from one person to another. No treatments or vaccines exist for these diseases. |
| **Examples** | E. coli K-12, S. cerevisiae (yeast), Lactobacillus, B. subtilis | Streptococcus, Herpes virus, most mammalian cell lines | Yersinia pestis (black plague), HIV, SARS virus | Ebola virus, Marburg virus, Lassa virus |

*A comprehensive classification of biological agents into risk groups is given in the annex of the EU directive 2000/54/EC.



# Biological hazards

### How do we come into contact with biological agents?

A wide variety of activities can bring you into contact with bacteria, viruses or fungi, for example:

1. The manufacture and use of biological agents (this includes, for example, isolation, production, propagation, use, processing, filling, transferring, mixing, supply and disposal).

2. Occupational contact with people, animals, plants, biological products, objects and materials (if this involves the release of biological agents and contact with them).

## Protective clothing according to EN 14126:2003

According to the EU directive 2000/54/EC on Biological Substances, employers are obliged to make suitable protective clothing available to their employees. What clothing provides protection against biological agents?

The European standard EN 14126** defines performance requirements for clothing materials to protect against infective agents. The test methods specified in this standard focus on the medium containing the microorganism; such as liquid, aerosol, or solid dust particle. Due to the heterogeneity of micro-organisms, the standard does not define performance criteria for specific types of micro-organisms. This subtle point needs to be considered in the risk assessment and with reference to the risk group of the infective agent itself. This European standard only refers to “materials” itself, with no infective-agent performance requirements on the seam. Since viruses, bacteria and spores are small enough to penetrate through the openings of sewn seams, suits with over-taped seams are recommended.

**Performance requirements and test methods for protective clothing against infective agents.

APPENDIX 3

# Protective garments categories, types and classes

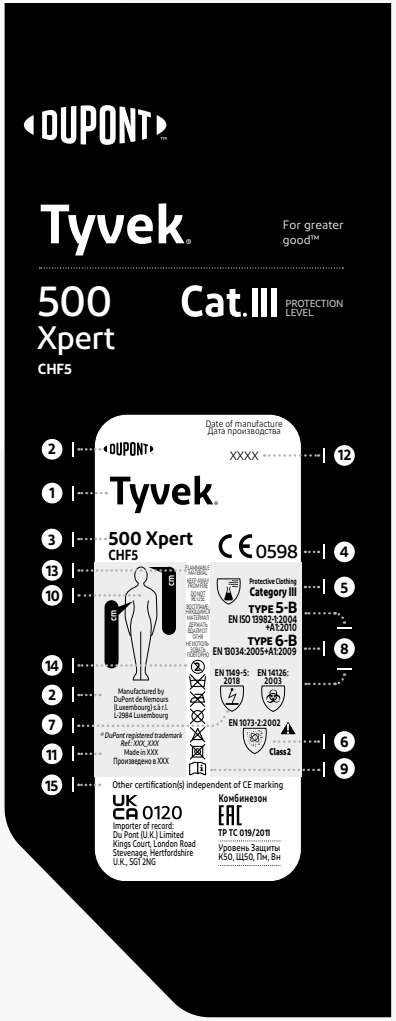
## Instructions for Use - information supplied by the manufacturer

This information must accompany every item of chemical clothing or every individual commercial packaging unit. The purpose is to guarantee that the wearer is confronted with these instructions prior to use.

The information must be at least in the official language(s) of the country or region of destination. It must be unambiguous and, if helpful, illustrations, part numbers, marking etc. can be included. If appropriate, warnings should be given against any problems likely to be encountered.

The instructions together with the information on the marking needs to contain at least the following information.

- the name, trademark, or other means of identification, and address of the manufacturer and/or his authorized representative established in the European Union or the country where the product is placed on the market;
- the reference number of the European Standard for the Type;
- the Type, e.g. Type 6 for light chemical splashes – protective suits;
- if applicable, additional items of personal protective equipment to be worn to ensure the level of protection needed and how to attach them;
- the manufacturer's type, identification or model number; the size range (as defined in EN 340);
- the names of chemicals and chemical products (including the names and approximate concentrations of the components) to which the protective clothing has been tested. This will include the performance levels obtained for liquid repellency and penetration for each chemical tested. If additional information is available, a reference to where this information can be obtained (e.g. manufacturer's telephone, fax number or website) shall be added;
- all other performance levels, as specified in Type defining norm, preferably in a table;
- a statement that chemical protective garments have been tested to the whole-suit test;
- for re-usable items: the explanation of care pictograms according to ISO 3758 and additional information on cleaning and disinfection (please see also EN 340, 5.4);
- the expected shelf-life of the garment if ageing can occur;
  - information necessary for trained persons on:
  - application, limitations of use (temperature range, antistatic properties etc.)
  - tests to be carried out by the wearer before use (if applicable)
  - fitting
  - use
  - removal
  - maintenance and cleaning (including guidance for decontamination and disinfection
  - storage
- if applicable, a statement to advise that the prolonged wearing of chemical protective suits may cause heat stress




EN • Instructions for Use
DE • Gebrauchsanweisung
FR • Consignes d'utilisation
IT • Istruzioni per l'uso
ES • Instrucciones de uso
PT • Instruções de utilização
NL • Gebruiksinstructies
NO • Bruksanvisning
DA • Brugsanvisning
SV • Bruksanvisning
FI • Käyttöohje
PL • Instrukcja użytkowania
HU • Használati útmutató
CS • Návod k použití
BG • Инструкции за употреба
SK • Pokyny na použitie
SL • Navodila za uporabo
RO • Instrucțiuni de utilizare
LT • Naudojimo instrukcija
LV • Lietošanas instrukcija
ET • Kasutusjuhised
TR • Kullanım Talimatları
EL • Οδηγίες χρήσης
HR • Upute za uporabu
SR • Uputstvo za upotrebu
RU • Инструкция по применению

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# The relationship between Garment categories, Types and Classes

In accordance with PPE Regulation (EU) 2016/425, it is an employer's responsibility to lay down minimum requirements for the assessment, selection and correct use of personal protective equipment. Priority must be given to collective safety measures. The following table provides you with a rule of thumb of how to assess risk in the garment selection process:

## Garment 'Categories'

PPE Regulation (EU) 2016/425 refer to three "Categories of PPE". These Categories are shown in the figure and demonstrate that the manufacturer of the product concerned has complied with the relevant performance requirements. In terms of protection, these categories relate to the protective properties of the entire garment where Category I offers the least protection and Category III relates to the highest protection. With Category III garments, in addition to the basic CE certification (according to Module B - Annex V of the PPE Regulation, the manufacturer must ensure the product continues to conform and meet the the declared performance EN Classes shown in the Instructions for use. Unlike Category I and II PPE, Category III PPE is subject to an annual audit by a Notified Body, which certifies continued conformity and issues a "Quality Surveillance Certificate" as per Module C2/D - Annex VII/VII of the PPE Regulation. Note that all Category III PPE must be identified with the digit code of the notified body appended to the CE mark.

**Table 2** **Risk assessment determines required garment performance.**

| | | |
|---|---|---|
| Level of exposure | → | Garment type* *please see Appendix 7* |
| Hazard/toxicity | → | Fabric barrier properties* *please see Appendix 4* |
| Level of exposure | → | Mechanical fabric properties *please see Appendix 4* |

**Table 3** **Categories of PPE and compliance with garment performance requirements.**

| PPE Category (Regulation (EU) 2016/425) | Definition | Logo | Initial EC-Type Certification from a notified body (Module B - Annex V**) | Manufacturer's declaration of Confirmity (Annex IX**) | Annual Quality Surveillance Certification by a notified body (Module C2/D - Annex VII/VIII**) |
|---|---|---|---|---|---|
| Category III (PPE of complex design) | Includes exclusively risks that may cause very serious consequences such as death or irreversible damage to health | CE XXXX** | Mandatory | Yes | Yes |
| Category II (neither simple nor complex PPE) | Protection against moderate risk where the product is tested for one value e.g. water resistant gloves or reflective tape for garments. | CE | Mandatory | Yes | Surveillance certification required every 5 years or in case of product modification |
| Category I (PPE of simple design) | Protection from minimal risks, self certification of products, exposure to dirt and grime e.g. gardening gloves, visitors' labcoats. | CE | Not required | Yes | Not required |

[1]OSHA online, Council Directive 89/656/EEC on the minimum health and safety requirements for the use by workers of personal protective equipment at the workplace
[2]European Commision online, Council Directive 89/686/EE on Personal Protective Equipment.
* Garment Type is linked to fabric barrier properties. ** Represents the 4 digit numeric code of the notified body.

## Garment Types

To facilitate the selection of Category III protective clothing are split into six levels of protection ('Types') with each Type being associated with a defined 'level of exposure' have been defined. Type I represents the 'highest' level of protection down to Type 6 which generally offers the 'lowest'. The six exposure levels are designed to equate to different modes of exposure to increasingly serious threats and are a frequently referred-to when specifying protective coveralls.

When selecting or specifying a Category III garment it is often referred to by its CE 'Type' certification. However this is not sufficient for an appropriate garment selection. Different protective garments that all meet the standards do not necessarily offer the same protection performance (please see Appendix 4). Different protective clothing products produced in compliance to a specific CE 'Type' can exhibit very different protection, durability and comfort performance characteristics. The CE 'Type' designation simply implies that a suit has passed one or more of the defined 'whole-suit' tests and meets the minimum mechanical and barrier requirements.

**Table 4** **Protection Types in Category III, chemical protective clothing.**

**Chemical Protective Clothing, Category III**

| Type and Pictogram* | Definition and Exposure Level | Product Standard and Year of publication |
|---|---|---|
|  **TYPE 1** **TYPE 1 - ET** | Gas-Tight<br>TYPE 1 – Protective clothing against liquid and gaseous chemicals, including liquid aerosols and solid particles.<br>TYPE 1 - ET – Performance requirements for emergency teams. | EN 943-1:2019**<br>EN 943-2:2019 |
|  **TYPE 2** | Non-Gas-Tight<br>Protective clothing against liquid and gaseous chemicals, including liquid aerosols and solid particles. | Exists under ISO 16602 |
|  **TYPE 3** | Liquid Tight<br>Protective clothing against liquid chemicals.<br>Exposure to pressurised jet of liquid. | EN 14605:2005/A1:2009 |
|  **TYPE 4** | Spray Tight<br>Protective clothing against liquid chemicals.<br>Exposure to a liquid spray aerosol (unpressurised). | EN 14605:2005/A1:2009 |
|  **TYPE 5** | Solid Particulates<br>Protective clothing against solid-airborne particulates. | EN ISO 13982-1:2004/A1:2010 |
|  **TYPE 6** | Limited protective performance against liquid chemicals<br>Potential exposure to small quantities of fine spray/mist or accidental low volume splashes and where wearers are able to take timely adequate action in case of contamination. | EN 13034:2005/A1:2009 |

* DuPont Pictogram. ** Amended in 2005.

## Other Relevant Standards

There are a number of other relevant PPE Standards that are applicable to protective clothing for particular applications and exposure hazards:

**Table 5** **Other relevant PPE standards**

| Other Relevant Standards | | |
|---|---|---|
| **Pictogram** | **Definition** | **Standard and Year*** |
|  ** | Protective Clothing with Electrostatic properties – material performance and design requirements. | EN 1149-5:2018 |
|  *** | Protective clothing against radioactive contamination. | EN 1073-2 :2002 |
|  | Protective Clothing with protection against heat and flame-Limited flame spread materials, material assemblies and clothing. Three 'Index' (levels) of protection are defined Index 1/0/0 → Index 1 performance, single use and no pre-cleaning or laundering. Index 1 materials limit the flame spread, but will melt and must always be worn on top of Index 2 or 3 garments. | EN ISO 14116:2008 |
|  | Protective clothing (fabrics) against infective agents (indicate by a 'B' e.g. Type 3-B) and comprising several fabric protection test methods. | EN 14126:2003 |

### Notes

For information on radioactive particulate protection please see Appendix 7.

## Fabric 'Classes'

In addition to the overall garment performance, the European standard for each garment Type also specifies a number of minimum performance requirements, known as the performance Class for the constituent fabrics and seams. These performance properties include technical attributes such as abrasion resistance, puncture resistance, tensile strength, and chemical permeation and penetration (please see Appendix 5). Each fabric property has usually between 1 and 6 performance Classes where Class 6 relates to the highest performance and Class 1 to the minimum performance requirement. This classification system for the fabric helps specifiers to differentiate between different functional characteristics.

These mechanical properties are a very important part of the protection equation because they introduce a 'durability' factor into the garment appraisal. Because fabric barrier tests are conducted on brand-new garments under static conditions, they do not indicate whether a barrier property will be maintained over time under real working conditions. Protective garments must perform from the moment they are put on to the moment they are taken off and in an operating environment they can be subject to stresses which might compromise the protective performance e.g. by abrasion or tearing.

* As standards are continuously revised the year of publication is subject to change.
** Antistatic treatments on DuPont chemical protective clothing are only effective in relative humidity >25% and when the garment and wearer are continuously and correctly grounded.
*** Does not protect against ionizing radiation.

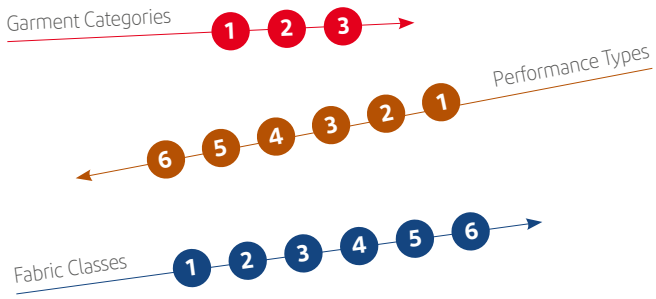
**Table 6** **Mechanical performance tests.**

| | Test method | Norm | Scope/Principle |
|---|---|---|---|
| Durability | Abrasion resistance | EN 530 Method 2 | Abrasion is the physical destruction of fibers, yarns, fabrics resulting from the rubbing of the fabric suface over an abrasive glass paper. It ultimately affects the appearance of the fabric and results in the loss of performance properties after a number of cycles. |
| | Flex cracking resistance | EN ISO 7854 Method B | Flex cracking simulates repeated flex and folds in the fabric. The number of cycles to failure indicated by cracks and holes is recorded. |
| | Tear resistance | EN ISO 9073-3 | Tear resistance determines the trapezoid tear resistance of a fabric by applying a continuously increasing extension in such a way that a tear propagates across the width. |
| | Tensile strength | EN ISO 13934-1 | Tensile strength determines the maximum force and elongation at maximum force of the fabric using a strip method. The fabric is extended at a constant rate until it ruptures. |
| | Puncture resistance | EN 863 | Puncture records the maximum force required to push a spike through the fabric with a constant rate until it perforates. |
| | Seam strength | EN ISO 13935-2 | Seam strength determines the maximum force of sewn seams when the force is applied perpendicularly to the seam which is extended until it ruptures. |
| Protection | Penetration by liquids | EN ISO 6530 | Gutter test method determines indices of penetration, repellency and absorption by applying a fine stream of a test liquid to the surface of a clothing material resting in a inclined gutter. |
| | Permeation by liquids | EN ISO 6529 Method A | Permeation test method determines breakthrough detection time at normalized permeation rate and cumulative mass by analysing quantitatively the chemical concentration that has permeated after initial continuous contact with the chemical. |
| | Surface resistance | EN 1149-1 | Antistatic test method is intended for materials used for electrostatic dissipative protective clothing to avoid incendiary discharge. A potential is applied to an electrode assembly rested on the fabric placed on an insulating base plate and the resistance of the fabric is recorded. The lower the resistance, the better the electrostatic dissipation performance. |

## A word of caution

It can be seen that there is a degree of inconsistency between the three classifications in that both the garment EN Categories and the fabric Classes use a rating scale where Level 1 represents the lowest level of protection and the highest number represents the highest level of protection. Paradoxically, however, the garment Type scale works the other way round with a Type 1 classification, i.e. the lowest number, referring to the highest level of protection! This anomaly can be very confusing to the specifier or user and it can be helpful to use some form of mnemonic or visual Aid Memoire to avoid mistakes.

**Figure 1** Visual Aid Memoire on garment Categories, performace Types and fabric Classes, **Source:** DuPont



# APPENDIX 4

# Fabrics types and properties

| Informational properties | | |
|---|---|---|
| Basis weight | EN ISO 536 | g/m² |
| Thickness | EN ISO 534 | µm |
| Resistance to water penetration | EN 20811 | cm $H_2O$ |
| Bursting strength | ISO 2758 | kPa |
| Air permeability (Gurley) | ISO 5636-5 | s |
| Water vapour resistance, Ret | EN 31092 | m².Pa/W |

Some of the physical properties of PPE fabrics are categorised under the fabric Classes mentioned in Appendix 3. Whole garment performance is covered in Appendix 7. For information on fabric test methods *please see Appendix 5.*

## Differents fabric properties

No matter what the brand or trade name, the majority of limited-use protective clothing products can be classified into one of a small number of broad fabric technologies. Although they may look the same, it is very important to realise that, in practice, these different technologies exhibit widely varying performance attributes. As a result a garment specifier or user must have a clear understanding of the technical properties of the various materials that might be considered for a given application.

Some protective fabrics, such as DuPont™ Tychem® and DuPont™ Tyvek® employ advanced proprietary technologies that have been specifically developed to provide a wide range of performance and comfort options to suit particular needs. Other fabrics are typically based on generic nonwovens and microporous films.

In order to select the appropriate protective garment, it is essential to understand how effectively a particular fabric performs as a barrier to specific hazardous materials. For details of Penetration Testing and Permeation Testing please refer to Appendix 4. To compare the physical attributes of the Category III garment Type 3, 4, 5 or 6 refer to the following table which shows minimum requirements for CE properties vs Type and informational characteristics.

**Table 7** **Minimum requirements for CE properties versus Type and informational characteristics.**

| | Test method | Norm | Unit | Type 6 | Type 5 | Type 4 | Type 3 |
|---|---|---|---|---|---|---|---|
| Durability | Abrasion resistance | EN 530 Method 2 | cycles | Class 1 >10 cycles | Class 1 >10 cycles | Class 1 >10 cycles | Class 1 >10 cycles |
| | Flex cracking resistance | EN ISO 7854 Method B | cycles | X | Class 1 >1000 cycles | Class 1 >1000 cycles | Class 1 >1000 cycles |
| | Tear resistance | EN ISO 9073-3 | N | Class 1>10 N | Class 1>10 N | Class 1>10 N | Class 1>10 N |
| | Tensile strength | EN ISO 13934-1 | N | Class 1>30 N | X | Class 1>30 N | Class 1>30 N |
| | Puncture resistance | EN 863 | N | Class 1>5 N | Class 1>5 N | Class 1>5 N | Class 1>5 N |
| | Seam strength | EN ISO 13935-2 | N | Class 1>30 N | Class 1>30 N | Class 1>30 N | Class 1>30 N |
| Protection | Penetration by liquids | EN ISO 6530 | % | Class 2<5% | X | X | X |
| | | EN ISO 6530 | % | Class 3>95% | X | X | X |
| | Permeation by liquids | EN ISO 6529 Method A | min | X | X | Class 1>10 min | Class 1>10 min |
| | Surface resistance | EN 1149-1 | Ω | <2.5E+09 optional | <2.5E+09 optional | <2.5E+09 optional | <2.5E+09 optional |
| | Charge Decay | EN 1149-3 | s | <4s optional | <4s optional | <4s optional | <4s optional |

### DuPont™ Tyvek®

Manufactured by a flash-spinning process, Tyvek® fabric is made of strong, continuous, high density polyethylene fibres. The fibres are thermally bonded into a tight, homogeneous and soft fabric that is intrinsically breathable, does not shed fibres ('linting') and has inherent barrier properties i.e. not reliant on a thin applied coating or layer. This unique combination of barrier protection and inherent breathability makes Tyvek® an ideal fabric for a wide range of protective applications.

### Microporous Film (MPF)

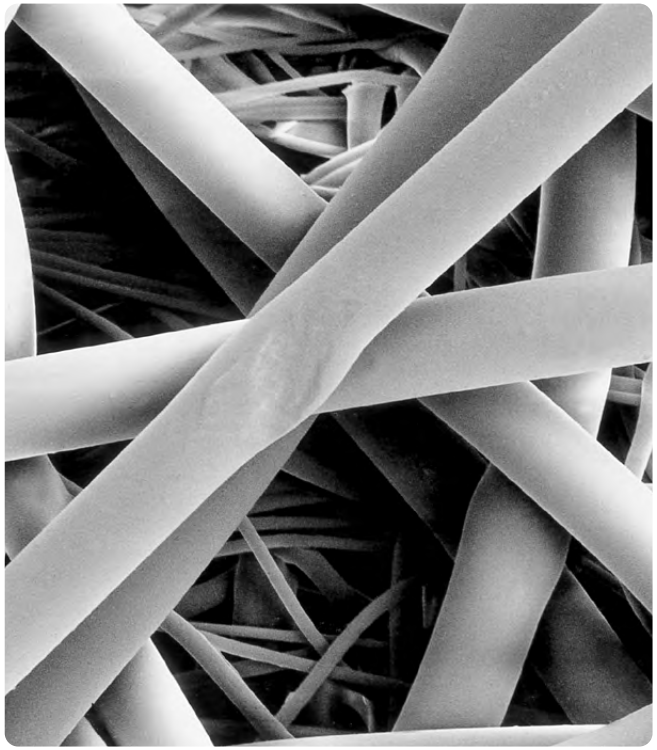
MPF fabrics are a bi-laminate material comprising a thin microporous film bonded to a spunbound polypropylene base. These fabrics offer limited durability since all barrier protection is lost when the protective film layer is abraded. In addition, their low air-permeability characteristics make then much less breathable than other fabrics with all this implies in terms of poor wearer-comfort and heat control.

### Spunbound/Meltblown/Spunbound (SMS)

The performance of SMS fabrics relies on a meltblown polypropylene layer sandwiched between two open spunbound polypropylene layers. This inner polypropylene layer functions as the main filter for particles. However SMS fabrics tend to suffer from limited durability and relatively weak barrier performance due to their relatively open fibre structure. In addition, their high air permeability characteristics significantly compromise the barrier properties of the fabric making it only really appropriate for very basic protection and as a dirt barrier.







**Source:** DuPont.

APPENDIX 5

# Fabric testing

## Mandatory Tests

A CE marking signifies that chemical protective clothing meets certain minimum requirements (please see Appendix 1). However, it does not mean that chemical suits of the same Type offer the same level of protection performance. This is why it is essential to look at the results of the tests carried out on the material used to make the garment. As part of the CE requirements a number of mandatory fabric tests are required and, for each Type, these are classified from Class 1 (lowest) to Class 6 (highest). For further information please see Appendix 3.

The following are the mandatory tests for mechanical performance that must be carried out on a fabric:

**Table 8** Mandatory tests for mechanical performance.

| | Test method | Norm | Scope/Principle |
|---|---|---|---|
| Durability | Abrasion resistance | EN 530 Method 2 | Abrasion is the physical destruction of fibers, yarns, fabrics resulting from the rubbing of the fabric suface over an abrasive glass paper. It ultimately affects the appearance of the fabric and results in the loss of performance properties after a number of cycles. |
| | Flex cracking resistance | EN ISO 7854 Method B | Flex cracking simulates repeated flex and folds in the fabric. The number of cycles to failure indicated by cracks and holes is recorded. |
| | Tear resistance | EN ISO 9073-3 | Tear resistance determines the trapezoid tear resistance of a nonwovens by applying a continuously increasing extension in such a way that a tear propagates across the width. |
| | Tensile strength | EN ISO 13934-1 | Tensile strength determines the maximum force and elongation at maximum force of the fabric using a strip method. The fabric is extended at a constant rate until it ruptures. |
| | Puncture resistance | EN 863 | Puncture records the maximum force required to push a spike through the fabric with a constant rate until it perforates. |
| | Seam strength | EN ISO 13935-2 | Seam strength determines the maximum force of seams when the force is applied perpendicularly to the seam which is extended until it ruptures. |

## Penetration vs Permeation

**Penetration** is the physical process whereby a liquid or solid passes through a material via "micropores", i.e. microscopic holes, in the fabric. It is especially relevant when referring to the particle penetration of a fabric or a whole suit. It is important to understand liquid penetration and repellency test data is generated during a 60 second test only. Consequently, it is only of value in the selection process to exclude those fabrics that allow chemicals to immediately penetrate. In order to assess whether a fabric protects the wearer against a specific chemical for durations exceeding 60 seconds, the permeation data must be consulted.

**Permeation** is the process by which a chemical, in the form of a liquid, vapour or gas, moves through protective clothing material at a molecular level and this 'molecular creep' can occur without any visible trace. This means it is possible for a liquid or vapour to permeate through a fabric even when there is no observed breaches or perforations in the fabric. The permeation process progresses in three steps: the substance is absorbed by the outside surface of the material; its molecules then diffuse through the material and finally the molecules desorb at the other surface (inside). The standard test duration for permeation is up to 8 hours or until permeation has been detected.

### Notes:

Fabrics used in garments certified to Type 6 are typicallyonly tested for liquid penetration and repellency. This is why the scope of type 6 garments is intended for applications with "potential exposure to small quantities of fine spray/mist or accidental low volume splashes and where wearers are able to take timely adequate action in case of contamination". Therefore, it is preferable to verify the permeation data of the fabric even for Type 6 garments. Permeation and Penetration should not be confused. Many 'microporous' fabrics which can offer good liquid repellency characteristics, i.e. low penetration properties, exhibit high permeation rates which means liquids, in practice, will quickly permeate through.

**Table 9** **Type 6 certified garments – tests.**

| | Test method | Norm | Scope/Principle |
|---|---|---|---|
| Protection | Penetration by liquids | EN ISO 6530 | Gutter test method determines indices of penetration, repellency and absorption by applying a fine stream of a test liquid to the surface of a clothing material resting in a inclined gutter. |
| | Permeation by liquids | EN ISO 6529 Method A | Permeation test method determines breakthrough detection time at normalized permeation rate and cumulative mass by analysing quantitatively the chemical concentration that has permeated after initial continuous contact with the chemical. |
| | Surface resistance | EN 1149-1 | Antistatic test method is intended for materials used for electrostatic dissipative protective clothing to avoid incendiary discharge. A potential is applied to an electrode assembly rested on the fabric placed on an insulating base plate and the resistance of the fabric is recorded. The lower the resistance, the better the electrostatic dissipation. |

## Chemical Permeation Test

The Chemical permeation of a material is tested according to the European standard EN ISO 6529. The resistance of a protective clothing fabric to permeation by a potentially hazardous substance is described by the determination of breakthrough time using the permeation rate as a cut-off.

1. Sorption of molecules of liquid onto the contracted (outside) surface.
2. Diffusion of the sorbed molecules across.
3. Desorption of the molecules from the opposite (inside) surface.

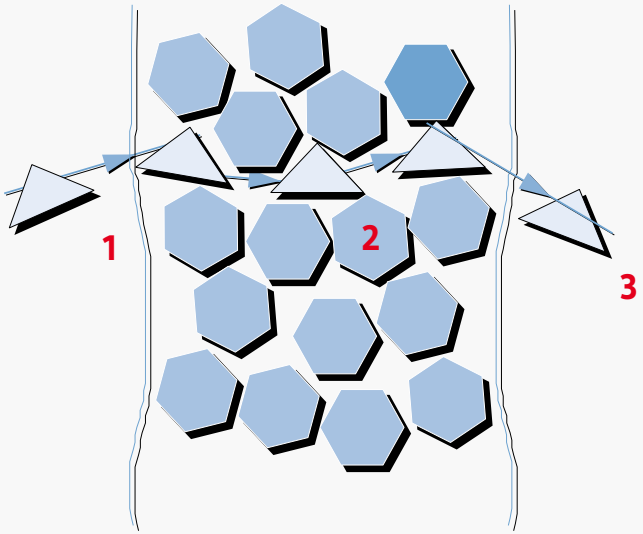



**Figure 2** Permeation, **Source:** DuPont

### The permeation test cell

The permeation test cell consists of two chambers that are separated by the fabric to be tested.The outside surface of the test fabric is exposed to the chamber containing the test medium (liquid or gaseous substance). Breakthrough of the substance is determined by measuring the concentration of the substance reaching the collection chamber per time unit.

### Permeation rate

This is the speed at which the test substance permeates through the test fabric. Permeation rate is expressed as mass of the test substance (µg) flowing through the fabric area ($cm^2$) per time unit (min).

### Steady State Permeation Rate (SSPR)

The SSPR is the level where the permeation rate reaches a maximum and continues at that. This is the state when all forces affecting permeation have reached equilibrium.

### Minimum Detectable Permeation Rate (MDPR)

This is the minimum permeation rate that can be determined in the test. MDPR is a function of the sensitivity of the analytical measurement technique, the volume into which the permeated chemical is collected and the sampling time.

Minimum detectable permeation rates can be as low as 0.001 µg/$cm^2$/min in certain cases.

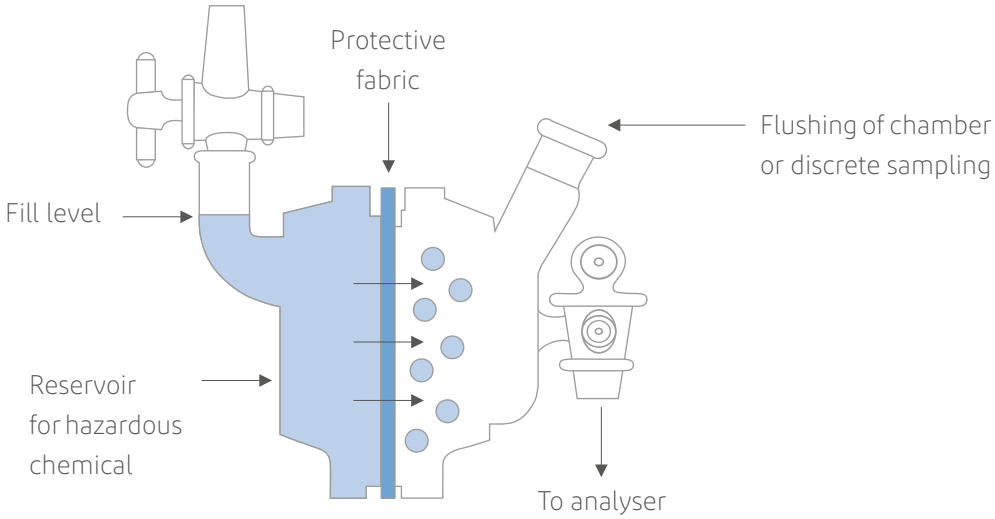



**Figure 3** Permeation test cell, **Source:** DuPont

## Barrier Breakthrough

The barrier or 'stopping' properties of a fabric are measured in terms of 'breakthrough time'; the time taken for a chemical or hazardous substance to penetrate completely through a fabric.

### Normalised breakthrough time

The classification of permeation data – as defined by EN 14325[1] – is based upon the normalised breakthrough time measured according to EN ISO 6529[2] at 1.0 µg/cm²/min. Normalised breakthrough time is the average elapsed time between initial contact of the substance with the outer surface of the protective clothing material and the time at which the substance is detected at the inside surface at a defined permeation rate. The breakthrough time is 'normalised' as it is independent of the sensitivity of the measuring device. A normalised breakthrough time of >8 hours means that the average permeation rate has never reached the rate defined according to EN ISO 6529 (0.1 µg/cm²/min or 1.0 µg/cm²/min). However, the substance may have actually broken through.

### Actual breakthrough

Actual breakthrough time is the average time elapsed between initial contact of the chemical or hazardous substance with the outer surface of the clothing material and the detection of the chemical on the inner surface by a measuring device. A permeation rate of 'ND' (not detected) does not necessarily mean that breakthrough cannot occur or has not occurred. It simply means that permeation was not detected after the test observation time of eight hours. Permeation may indeed have taken place, but at less than the minimum detectable permeation rate (MDPR) of the measuring device. MDPR can vary depending on the sensitivity of the analytical device for the given substance.

**Notes:**

Breakthrough time alone is not sufficient to determine how long a garment may be worn once it has been exposed to contamination. Safe user weartime may be longer or shorter than the breakthrough time depending on the permeation behaviour of the substance, its toxicity and the exposure conditions. In case of mixtures, permeation is measured for the most toxic substance since permeation cannot be measured for chemical mixtures. Account must be taken of the fact the permeation characteristics of mixtures can often deviate considerably from the behaviour of the individual chemicals. Furthermore, permeation rates are temperature dependent and typically increase with a temperature rise.

**Table 10** **Normalized breakthrough time and EN Class.**

| Normalized breakthrough time at a permeation rate of 1.0 µg/cm²/min in minutes | EN Class* |
|---|---|
| > 10 | 1 |
| > 30 | 2 |
| > 60 | 3 |
| > 120 | 4 |
| > 240 | 5 |
| > 480 | 6 |

1 EN 14325:2004 - Protective clothing against chemicals. Test methods and performance classification of chemical protective clothing materials, seams, joins and assemblages.
2 EN ISO 6529:2013 - Protective clothing. Protection against chemicals. Determination of resistance of protective clothing materials to permeation by liquids and gases.
* EN 14325: Protective clothing against chemicals – test methods and performance classification of chemical protective clothing.

## Liquid penetration and repellency test

The liquid penetration and repellency test is performed according to EN ISO 6530[1] (superseding EN 368) and is often referred to as the 'Gutter Test'.

### Schematic of the test apparatus

In this test, the protective material to be tested is placed in an inclined gutter (45°) which is lined with an absorptive detector fabric. 10 ml of liquid is applied in 10 seconds onto the top of the test material via a syringe needle.

### Penetration index

Any liquid which penetrates the fabric via the fabric pores within 1 minute is absorbed by the detector fabric and expressed as percentage of the original quantity and is a measure of the penetration of the fabric.

### Repellency index

The amount of liquid collected in the beaker after 1 minute is expressed as percentage of the original quantity and is a measure of the repellency of the fabric. Note that EN ISO 6530 only requires four chemicals to be tested. Caution should be applied when interpreting penetration results since the test simulates exposure to small amounts of chemicals (10 ml) and short time (1 minute) only. Furthermore, for volatile chemicals it should be considered that some of the test substances would have evaporated during the test which can falsify the penetration data obtained. This is why EN ISO 6530 states that volatile substances (and their results) have to be identified as such. A protective clothing material with excellent results in the penetration test may give only poor protection when exposed to the same chemical in larger quantities and/or for extended time. To determine whether a protective clothing material with a low penetration index is really a protection against a specific liquid chemical, the chemical permeation data needs to be consulted.

## Chemical mixtures

Permeation characteristics of a mixture of chemicals can often deviate considerably from the behaviour for the individual chemicals. If protection against a mixture of hazardous chemicals is required, we recommend you contact the manufacturer for expert advice.

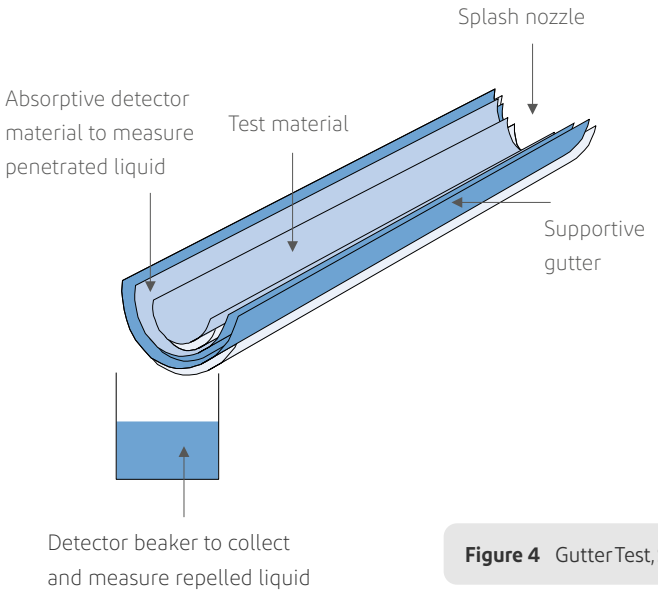



**Figure 4** Gutter Test, **Source:** DuPont

**No chemical permeation data for your chemical?**

DuPont can facilitate the independent permeation testing of your specific chemical or chemical mixtures with the DuPont barrier fabrics.

[1]EN ISO 6530:2005 Protective clothing. Protection against liquid chemicals. Test method for resistance of materials to penetration by liquids.

# Protective clothing against infective agents

Protective clothing against infective agents has to prevent infective agents from reaching the skin and to prevent the spreading of infective agents to other people and other situations, e.g. eating or drinking, when the person has taken his protective clothing off. The European Standard EN 14126 specifies requirements for clothing materials providing protection against infective agents. The test methods specified in this standard focus on the medium containing the micro-organism, such as liquid, aerosol or solid dust particles. EN 14126 comprises the following material tests:

**Table 11** **Protection against infective agents (EN 14126) test methods.**

| | Test method | Norm | Scope/Principle |
|---|---|---|---|
| Biobarrier | Resistance to penetration by blood and body fluids using synthetic blood | ISO 16603 | The material is subjected to a body fluid simulant (synthetic blood) for a specified time and pressure sequence. A visual observation is made to determine when penetration occurs. The highest pressure with no visible penetration of synthetic blood is recorded. |
| | Resistance to penetration by blood-borne pathogens using Phi-X174 bacteriophage | ISO 16604 | The material is subjected to a nutrient broth containing a virus for a specified time and pressure sequence. Visual detection is supplemented with an assay procedure that will detect viable viruses which penetrate the material even when the liquid penetration is not visible. |
| | Resistance to penetration by contaminated liquids | EN ISO 22610 | The test method involves superimposing the bacterial contaminated donor (Staphylococcus aurus) material onto the fabric and subjecting it to mechanical rubbing. Due to the combined effect of rubbing and liquid migration, bacteria may spread from the donor material through the fabric down to the agar surface. |
| | Resistance to penetration by contaminated aerosols | ISO/DIS 22611 | The test method exposes a material to a bacterium (Staphylococcus aurus) suspended in an aerosol and sprayed onto both an unshielded filter and one shielded with the test material. The ratio of bacteria found on the shielded (bacteria passed through) and unshielded (background bacterial count) filter is used to assess the barrier properties of the test material. |
| | Resistance to penetration by contaminated solid particles | ISO 22612 | A portion of talc contaminated with Bacillus subtilis spores is poured on the fabric and captured on a sedimentation plate (Petri dish) after vibration for 30 minutes. After 24h incubation of the sedimentation plate, the number of colonies produced are counted. |

Protective suits made of EN 14126 compliant fabrics must also meet the whole suit requirements specified in the relevant chemical protective clothing "Type" standard. They must be CE Certified as Category III and can be identified by the biohazard pictogram. The clothing Types to protect against biological agents are broken down as follows:

**Table 12** **Protective clothing Types according to EN 14126:2003.**

| Type | Description | Relevant standard |
|---|---|---|
| 1a-B, 1b-B, 1c-B | Gas-tight | EN 943-1:2019, EN 943-2:2019 |
| 2-B | Non gas-tight | EN 943-1:2019, EN 943-2:2019 |
| 3-B | Protection against pressurised liquid chemicals | EN 14605:2005 +A1:2009 |
| 4-B | Protection against liquid aerosols (spray tight) | EN 14605:2005 +A1:2009 |
| 5-B | Protection against airborne solid particulates | EN ISO 13982-1:2004 +A1:2010 |
| 6-B | Limited protection against liquid chemicals (light spray) | EN 13034:2005 +A1:2009 |

DuPont Personal Protection offers protective suits which cover all four risk groups as well as Types 3 to 6. Depending on the form of biological agent, the levels of exposure, the nature of the work and the risk of infection, the barrier performance of the fabric to the relevant infective agent test(s) should be considered.

The type of seam and the material's mechanical robustness also needs to be taken into consideration. For instance, in the case of viruses, such as Ebola, performance with regard to their resistance to penetration by blood-borne pathogens (ISO 16604) is key.

APPENDIX 6

# GMP Annex 1

## How to validate protective cleanroom garments ?

The revised GMP Annex 1 for the manufacturing of sterile products, published on August 25th, 2022, emphasizes the importance of managing processes, equipment, facilities, and production activities in accordance with Quality Risk Management (QRM) principles. This proactive approach requires a complete understanding of processes and potential quality risks in order to put in place technical and procedural means to control these risks. Cleanroom garment systems, being a critical part of sterile and aseptic manufacturing, must also be managed under QRM principles. The new Annex 1 calls for scientific evaluation and control of potential risks to quality, including the risk of contamination from cleanroom operators and their garments. Testing methods are proposed for evaluating the filtration and retention efficiency, particle shedding, and particle filtration efficiency of cleanroom garments. These tests can be measured, scientifically tested, and documented, meeting the expectations of the new GMP Annex 1.

The following standardised testing methods can be used to assess the cleanroom garments:

### The particle filtration efficiency as per EN 143 (TSI 8130)

The particle filtration efficiency (PFE) measures the filtration efficiency of the material used for cleanroom garments against the dry particles shed by the operators (i.e., skin flakes, even when stationary, people generate approximately 100,000 particles of 0.3 micron(µm) or greater).

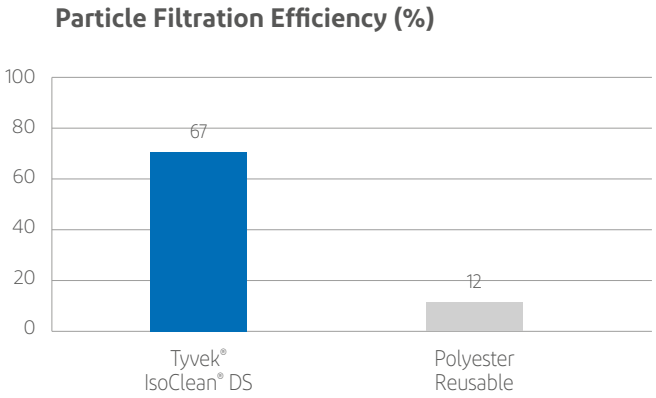



**Figure 5** Internal test, **Source:** DuPont

### The bacterial filtration efficiency as per ASTM F2101

The bacterial filtration efficiency (BFE) measures the filtration efficiency of the material used for cleanroom garments against bacteria shed by the operators.

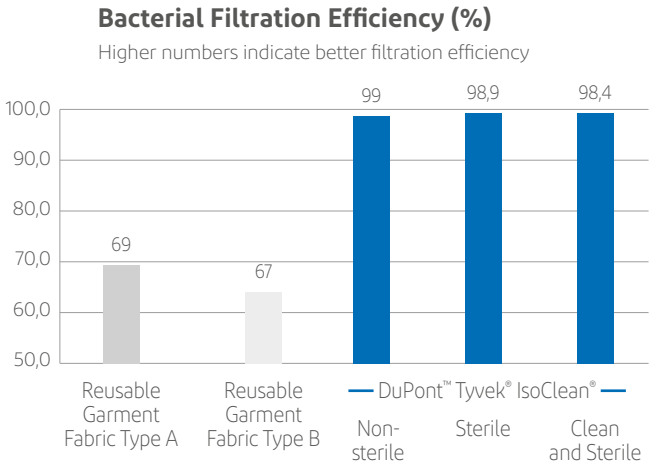



**Figure 6** *Results average of 10 measurements per fabric type from "as-received" garments **Results as reported in SafeSPEC

### The Helmke Drum test method as per IEST-RP – C003.4

The Helmke Drum is a rotating drum, with a rotating speed of 10 turns per minute, in which the cleanroom garments are being tumbled while a particle counter inside the drum is measuring the concentration of particles per minute for the sizes 0.3 µm and 0.5 µm. The results are then classified into 3 categories based on the number per size of particles released (Class I being the best and class III the worst result). The clean and clean & sterile Tyvek® IsoClean® products all meet the class I and DuPont provides these test results on a certificate of compliance that comes with every box of products.

### The Body box test as per IEST-RP-CC003.4

This test is done inside a small cleanroom cabin in which an operator wearing a cleanroom garment system is performing a series of predefined movements during which the particles inside the body box are being measured and counted. This test best mimics real wearer conditions inside a cleanroom.

**The sterility of cleanroom garment systems is also emphasized in the GMP Annex 1. All sterile Tyvek® IsoClean® products have a validated sterility assurance level of $10^{-6}$ as per ANSI/AAMI/ISO 11137-1 and with every box comes a certificate of sterility.**

Overall, the selection of cleanroom garment systems should be based on scientific data and part of a structured and well-documented approach that fits into the QRM-based contamination control strategy. DuPont offers different products for the different pharmaceutical cleanroom classes: Tyvek® Isoclean® product ranges for grade A/B cleanrooms and Tyvek® 500 and Tyvek® 600 Plus coveralls for grade C/D cleanrooms.

Please visit **our website** for more information and documentation on our cleanroom garments.

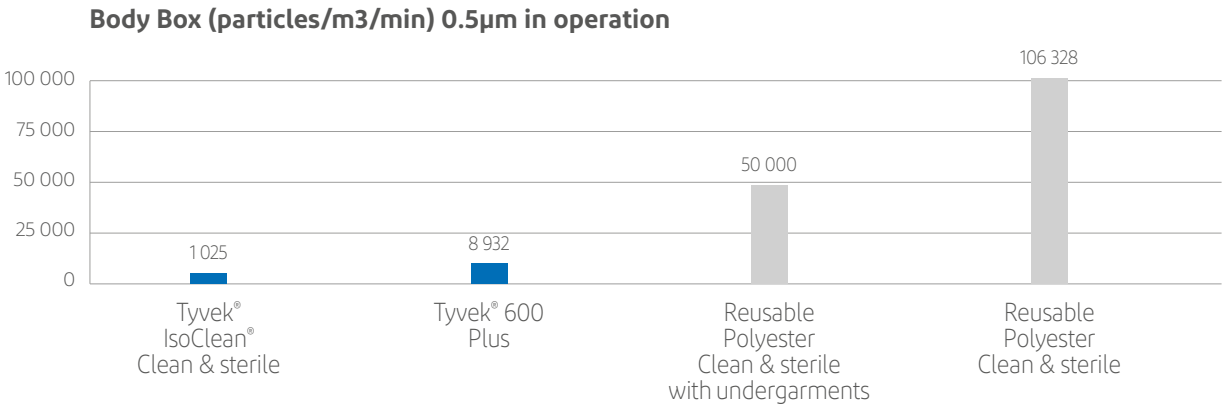



**Figure 7** Kontaminationsquelle Mensch_2020_(01-2010).indd (dastex.de) for the reusable garments, **Source:** Study by DuPont & C. Moschner

APPENDIX 7

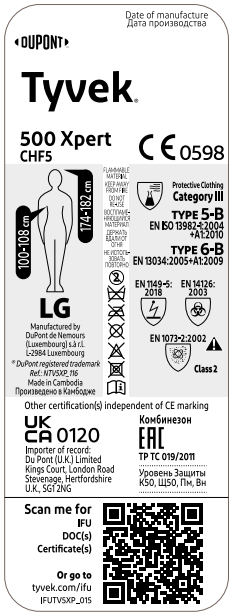
# Whole garment performance

'A chain is no stronger than its weakest link' is a principlethat strongly applies to protective garments. A first class barrier fabric will be severely compromised if it forms part of a coverall with weak seams, unreliable closures and poor ergonomics. For this reason it is important that whole-garment tests are conducted to indicate protective performance and wearability in use.

The presence of a CE-mark on a coverall signifies that the garment complies with the safety requirements of the European PPE Directive /PPE Regulation (EU) 2016/425 and in the case of a Category III suit will include the registration number of the Notified Body, in the form 'CE- - - -', that certifies ongoing fulfilment.

CE

UK CA




## Type Testing

In accordance with the EU CE requirements (please see Appendix 1), chemical protective (Category III) clothing is subdivided into six levels or 'Types' of protection (please see Appendix 3) each carrying a Type-test certificate relating to tests for different kinds and degrees of hazard exposure. In order to be certified as offering a particular 'Type' of protection, a fabric's physical and barrier properties must also meet minimum performance requirements (please see Appendix 4) and for Types 3, 4, 5 & 6, the whole suit itself must be tested to a minimum of one of the whole suit 'Type' tests and pass a dynamic movement test.

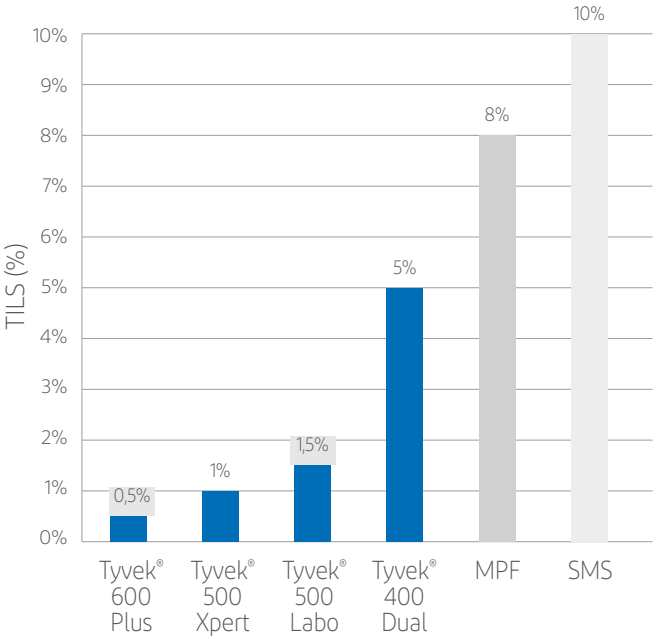
### A word of caution

The EN whole-suit Type-tests (please see Appendix 4) define a maximum allowable amount of challenge test liquids, aerosols or particulates to ingress into the suit.

### Example

For example, for the Type 5, 80% inward leakage average results must be lower than 15% of inward leakage. For the Type 6 low level spray test, penetrationspots at a maximum of 3 cm² of the test liquid are allowed on the undergarment.

In other words, allocation to a specific protection Type is not a sign that all protection suits of this type have the same barrier properties. Rather, protection offered by Type 5 suits can differ greatly in terms of the actual particulate barrier they provide, depending on the suit fabric, seam construction, design and whether the testing has been conducted with additional barriers, such as taping around the cuffs, ankles and hood/mask. Only by having a look at the detailed results can a user arrive at conclusions with respect to the actual barrier and impermeability properties of a given suit of a particular Type.




The suits were tested with a full face mask, boots and gloves taped at mask, cuffs, ankles and flap.

**Figure 8** Total Inward Leakage (TILS): Average of the 10 suits and all activities EN ISO 13982 - (1 and 2).
Dry particles Sodium Chloride NaCl 0,6 µm,
**Source:** Independent Institute

## Whole-suit Type Tests

For a abridged description of the conditions of the whole-suit Type tests please refer to Appendix 2 – The Relationship between Garment Categories, Types and Classes.

Radioactive particulate matter is dust and very fine particles which have been exposed to ionising nuclear radiation. Unless contained and managed these contaminated particulates not only present a serious health hazard to any personnel in proximity but, without proper safeguards, there is a further risk of radioactive particulates being inadvertently transferred elsewhere, for example to uncontained workplace areas. This is due to the ease with which microscopic radioactive particles can attach to clothing, footwear, tools and other items in the exposure zone and then be subsequently dispersed unknowingly into 'safe' environments.

### EN 1073-1 and EN 1073-2

Chemical protective garments are intended for single use so that a cross-contamination with radioactive particles can be minimized. DuPont offers specially designed garments that help provide protection from radioactive particles and liquids. Specific fabric types, seam configurations and garment designs should be specified to match the hazard. In general, more body coverage is better: Hooded coveralls (with attached socks) or fully encapsulated coveralls help to protect the entire body from radioactive particulates. DuPont™ Tyvek® 500 Xpert, Tyvek® 600 Plus, Tyvek® 800 J, Tychem® 2000 C Standard, as well as Tychem® 6000 F Standard garments & Tychem® 6000 AL are tested according to EN 1073-1 or EN 1073-2 as protective clothing against radioactive contamination. EN 1073-1 standard is designed for compressed air line ventilated protective clothing, protecting the body and the respiratory tract, and EN 1073-2 for non-ventilated protective clothing against particulate radioactive contamination.

### EN 1073-1: requirements & test methods for compressed air line ventilated protective clothing, protecting the body & the respiratory tract

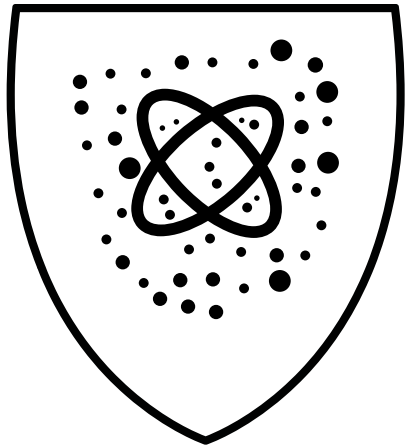
The tests are run in a cabin containing very fine salt particles with an operator wearing a ventilated protective clothing while doing a series of movements. The particles measured inside the coverall (both in the respiratory area and in body) will be compared with the particle concentration within the cabin (outside of the coverall) to assess the nominal protection factor (NPF).

There are five types of performance class to describe the suit particle protection level: Class 1 = the lowest particle barrier with a NPF of 2000
Class 5 = the highest particle barrier with a NPF of 50000

### EN 1073-2: requirements & test methods for nonventilated protective clothing against particulate radioactive contamination

The EN 1073-2 standard was developed with the nuclear industry in mind, but does not apply for the protection against ionizing radiation. The 1073-2 standard itself is very similar to the Chemical Protective Clothing Type 5 standard (EN ISO 13982-1). With respect to whole suit particle protection levels, both standards reference the testing protocol "Protective clothing for use against solid particulates - test method of determination of inward leakage of aerosols of fine particles into suits" (EN ISO 13982-2). This test essentially determines the barrier efficiency of the suit when challenged with sodium chloride particulates of a defined size distribution. The results are then used to determine both a performance classification and a "nominal protection factor", analogous to respiratory standards.For EN 1073-2, when tested according to EN 13982-2, six suits are tested. The total inward leakage results (TIL) are reported, as a ratio (in %) of the test particle concentration inside the suit & the test chamber.There are three types of performance class to describe the suit particle protection level: Class 1 = Lowest particle barrier with a NPF of 5Class 3 = Highest particle barrier with a NPF of 500

For further information, on the EN 1073-1 and EN 1073-2, please refer to our technical flyer on nuclear risks.

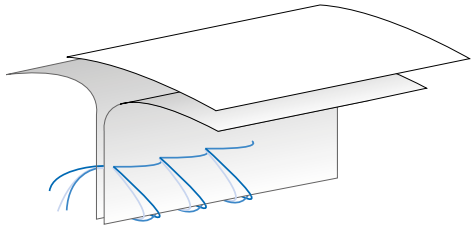


## Seam construction and performance

Garment seam design and quality is a very important consideration. All protective garments employ seams in their construction and due attention must be devoted to ensuring that the seam technology employed is up to requisite standard. It is not enough for a garment to be manufactured using the best barrier fabric if the seams are weak or leak. Different seaming configurations and connection systems are available which provide the necessary strength and impenetrability for different hazard and usage situations. The same considerations apply to closure systems such as zips and storm flaps, and to garment interfaces and boundaries in the neck, hood, wrist and ankle areas.

All Category III chemical protective clothing must undergo a seam strength test as well as the relevant "whole suit" inward leakage test. Tight, reliable seams are an absolutely critical element in the overall barrier protection performance of a garment therefore when selecting a garment, it is important to verify the seam performance in addition to the fabric performance. Just because a seam is tight doesn't mean that it is impermeable and vice versa. Stitched seams on their own, for example, are never so fully tight that gas or particulates cannot penetrate. By properly overtaping a stitched seam, however. it can be made as tight and strong as the parent fabric material.

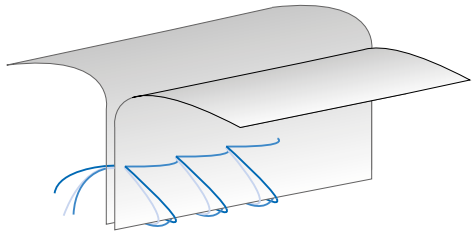
Type 3/4



### Stitched & Overtaped seams

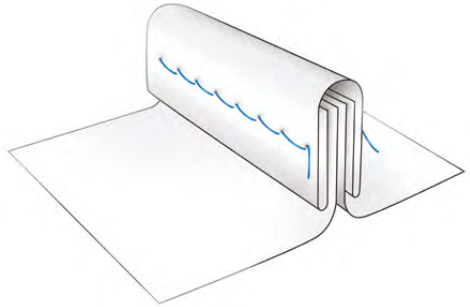
Seams can be stitched and overtaped. The tapes used for DuPont products with this type of seam offer a barrier equal to that of the fabrics.

Type 5/6



### Stitched seams

Stitching offers good balance between seam strength and seam barrier.



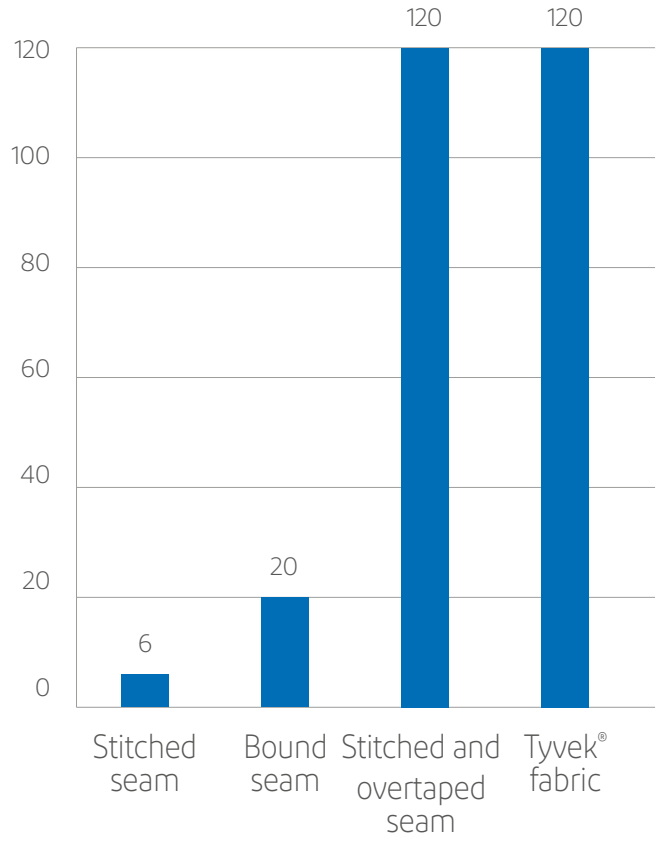
### Bound seams

Seam construction leaves the needle holes visible. Construction is unlikely to offer permeation barrier equal to the fabric.

**Figure 9** Three types of seam construction, **Source:** DuPont

## Pressurised exposure resistance

Hydrohead is an indicator for pressurised exposure resistance. The test is based on water column test, stichted and overtaped seams are tight and offer the same barrier as the fabric itself.

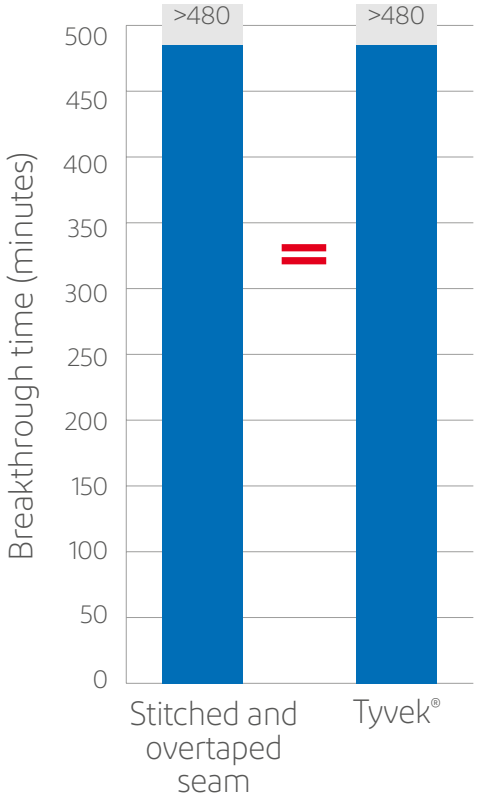



N=16 specimens tested

**Figure 10** Pressurized exposure resistance. Hydrohead DIN EN 20811 (centimeters of $H_2O$), **Source:** DuPont

## Permeation results

Based on permeation test, stitched and overtaped seams are tight and offer the same barrier as fabric.




N=16 specimens tested

**Figure 11** Permeation EN ISO 6529 with Sulfuric acid 18% (BT 1.0 normalized breakthrough time at 1.0 µg/cm²/min.), **Source:** Independent laboratory

APPENDIX 8

# Comfort considerations

## Key comfort factors

Comfort is a somewhat subjective and personal matter but some key comfort factors frequently cited in wearer trials include:

- Garment design: ample freedom of movement when bending/stretching.
- Breathability: ability of the garment to allow sweat to evaporate and provide moisture vapour permeability.
- Feel on the skin, softness. Garment weight.
- Wearing undergarments such as cotton that absorb sweat improves the "feel" on the skin.
- Wearing long-legged and long-sleeved undergarments.

Garments with air and moisture vapour permeability will be more comfortable than non-breathable materials and coated fabrics but this is usually at the expense of particulate or chemical barrier properties.

## The need for comfort

When it comes to day-in day-out health and safety compliance, operator comfort is one of the key 'human factors' that govern the correct use of personal protective equipment (PPE). The importance of wear comfort and correct garment fitting cannot be overstated. A large proportion of observed PPE non-compliance occurrences are not due to an absence of protection but are simply due to workers avoiding, misusing or abusing the protection provided. And even where staff are wearing the appropriate equipment, if it doesn't fit or if it isn't comfortable then it is often being worn incorrectly[1].

## Discomforting costs

While providing necessary protection to the user, the wearing of PPE (personal protective equipment) invariably creates an impediment to worker performance, communications and comfort. In some cases the provision of personal protection comes at a high cost in terms of operator comfort and efficiency and, unless carefully managed, these are conflicts that can lead to field operators being exposed to further risks and for a tendency for otherwise effective workwear to be shunned, used incorrectly, or unofficially modified.

## Finding the optimum balance

PPE misuse may just be just down to a momentary lapse of attention but that's all it takes for yet another casualty to be added to the workplace accident statistics. Fatigue, restricted movement, reduced dexterity, impeded vision, low tactile sensitivity and even annoying fabric rustle, are just some of the reasons that cause workers to shun, abandon or misuse protective equipment. The secret rests in finding the optimum balance between comfort and protection, between safety and productivity, between fit and functionality.

High performance PPE ensembles, while providing effective chemical protection, can serve to introduce new risks relating to physiological and psychological stresses. For example the life-threatening dangers of hyperthermia (heat stress) from unventilated protective garments are well documented. Similarly, the psychological impacts associated with wearing constrictive, bulky and sometimes claustrophobic worksuits are perhaps less well documented but every bit as real. Anything which can negatively affect the judgement of an operative in a highly dangerous, highly stressful environment must be taken very seriously.

[1] Health and Safety Laboratory for the Health and Safety Executive, Human factors that lead to non-compliance with standard operating procedures, 2012.

## Size matters

Comfort, safety and productivity are partly a function of garment size and fit. A full range of coverall sizes is absolute necessity since there is a clear correlation between fit and function when it comes to protective coveralls. For example, by comparison, a single size of footwear or gloves cannot be expected to fit an entire workforce. Garments that are either too big or too small introduce unnecessary risks. Loose, non-breathable fabrics will contribute to a 'bellows effect' potentially causing unwanted air exchanges between the worker and his/her surrounding environment and will be easy to snag, awkward to wear and potentially restrict the wearer's vision. On the other hand, tight body-hugging coveralls will tend to expose the body's extremities, will be dangerously stressed during bending and stretching movements, will significantly impede movement and be very uncomfortable to wear.

## Garment cut

Be aware that low-cost coveralls will often skimp on the cut to reduce fabric usage and this can have unacceptable consequences. Over-tight garments will pinch and pull, the fabric will be unduly stressed, they will be uncomfortable to wear, they might restrict movement and the seams can be stretched and break or open up and lose their efficacy. It is not only comfort and efficiency that is at stake, the worker's health and safety will be unnecessarily put on the line.

The Tyvek® barrier fabric from DuPont uses a proprietary non-woven fabric structure to provide a protective fabric that actually allows moisture vapour to pass through.

The material is formed from High Density Polyethylene (HDPE), with diameters as low as 1/150$^{th}$ of a human hair, which are spunbonded into a tough, light, homogeneous fabric with inherent vapour breatheability characteristics on account of its microscopic lattice structure.

This inherent ability to evacuate body moisture results in greatly improved wearer comfort in many Type 4,5 and 6 applications.

## Humidity between underwear and garment

With their open structure, SMS coverall removes better the humidity than Microporous Film, by far. Tyvek® garment meets quite good performances during sweating. Microporous Film is the material that takes the longest time to remove humidity.

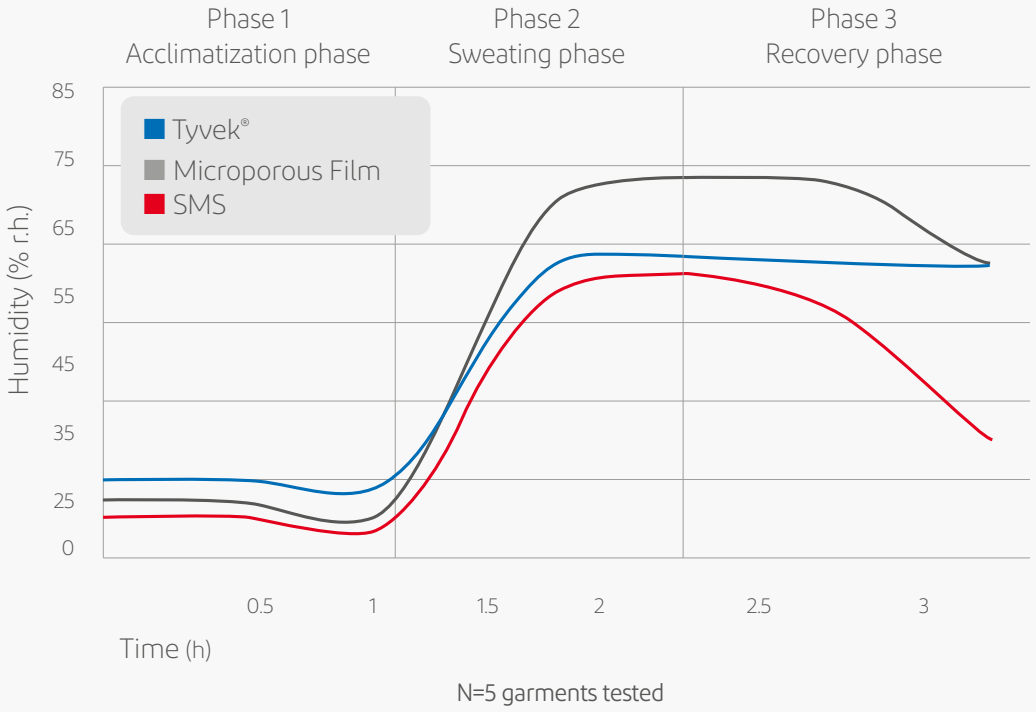



**Figure 12** Humidity between underwear and garment (by family)
**Source:** Independent Institute

APPENDIX 9

# Static electricity discharge

## The electrostatic properties of protective clothing

The rubbing of a synthetic material against the skin or undergarments is sufficient to permit electrostatic charges to build up on the fabric. These triboelectric effects of a fabric can generate thousands of volts and a charge dissipation via a tiny spark from a coverall to a surface of opposite electrical potential in a flammable, gaseous, or dust-charged atmosphere could result in a catastrophic explosion.

## Safety in explosive environments

Companies operating in sectors such as the chemical, pharmaceutical, industrial coatings and gas supply industries use combustible materials that can potentially create explosive atmospheres.

These 'explosive protection zones' or 'EX-Zones' are classified into various categories depending on the frequency and length of time that the hazard exists.

Combustible gases and vapours are classified into three explosion groups (IIA, IIB and IIC) according to the minimum amount of energy required to ignite them. The most easily ignitable group is class IIC.

## Antistatic features in protective clothing

Antistatic finishes for limited-use garments generally work by using the moisture of the air to turn the finishing-compound into a charge-conductive surface. This means, that if there is enough moisture in the air – typically above 25% RH – the antistatic property is 'active'. If however the moisture level is below 25% RH, the antistatic property will be either reduced or perhaps completely absent, depending on the prevailing humidity level.

**Table 13** Categories of Ex-Zones.

| Ex protective Zones for gases, vapours and mists | | Ex protective Zones for dust | |
|---|---|---|---|
| **Zone 0** | A place in which an explosive atmosphere consisting of a mixture with air of dangerous substances in the form of gas, vapour or mist is present continuously or for long periods or frequently. | **Zone 20** | A place in which an explosive atmosphere in the form of a cloud of combustible dust in air is present continuously, or for long periods or frequently. |
| **Zone 1** | A place in which an explosive atmosphere consisting of a mixture with air of dangerous substances in the form of gas, vapour or mist is likely to occur in normal operation occasionally. | **Zone 21** | A place in which an explosive atmosphere in the form of a cloud of combustible dust in air is likely to occur in normal operation occasionally. |
| **Zone 2** | A place in which an explosive atmosphere consisting of a mixture with air of dangerous substances in the form of gas, vapour or mist is not likely to occur in normal operation but, if it does occur, will persist for a short period only. | **Zone 22** | A place in which an explosive atmosphere in the form of a cloud of combustible dust in air is not likely to occur in normal operation but, if it does occur, will persist for a short period only. |

**Source:** Directive 99/92/EC

**Table 14** Examples of explosion groups.

| IIA | IIB | IIC |
|---|---|---|
| Acetone<br>Benzene<br>Toluene | Ethylene<br>Ethylene oxide<br>Diethyl ether | Acetylene<br>Hydrogen<br>Carbon disulphide |

**Source:** TRBS 2153 – Technische Regel für Betriebssicherheit, Vermeidung von Zündgefahren infolge elektrostatischer Aufladungen – www.baua.de

## Earthing

In order to avoid the creation of sparks (that might ignite an explosive atmosphere or cause operator discomfort), the garment and the wearer need to be properly grounded. This means that both the clothing and the wearer must be continuously earthed, taking care to ensure that the correct fabric side (inner or outer) is grounded in those cases where the garment's antistatic treatment is limited to one side. Special attention must also be paid to garments with attached socks or overshoes.

There are some essential rules for the safe discharge of static electricity:

- Both wearer and garments must be correctly and continuously grounded via conductive safety shoes, floor and/or grounding cable.
- Electrostatic charges may build up on ancillary equipment. Breathing apparatus and other devices must therefore be separately grounded when being worn in conjunction with a garment.

## Single-sided versus double-sided

Some fabrics, particularly multi-layer, coated and coloured fabrics, may be antistatic treated on one side of the material only. An antistatic coating on both sides of a garment will reduce antistatic build-up and the attraction of particulates. However, neither single- or double-sided coatings will necessarily prevent the risk of ignition in highly explosive conditions such as hydrogen atmospheres and oxygen-enriched air. In these cases the garment manufacturer must be consulted for guidance. In all situations the garment must be adequately grounded. With one-side treated garments care must be taken to ensure that it is the surface of the clothing which has been given antistatic treatment that is earthed.

## ATEX Directives

For standard chemical protective clothing it is not a compulsory requirement for garments to be antistatically treated or have antistatic features. However due to the prevalence of operations and applications being managed under ATEX controls it is a much-requested feature.

Organizations in the EU must follow the ATEX[1] Directives to protect employees from explosion risk in areas with an explosive atmosphere.

There are two ATEX directives:

- The new ATEX Directive 2014/34/EU[2] is for equipment manufacturers and covers equipment and protective systems intended for use in potentially explosive atmosphere.
- The 'ATEX 137' workplace directive 99/92/EC[3] provides minimum requirements for improving the safety and health protection of workers potentially at risk from explosive atmospheres.

## Antistatic certifications

In order to compare antistatic properties of chemical protective clothing on a standardised level, there are several norms which manufacturers can use. With such norms the surface resistance and the charge-decay properties of fabrics can be measured and/or assessed. The surface resistance is covered by EN 1149-1 and the charge-decay is covered by EN 1149-3. EN 1149-1 is mostly used for finished fabrics, whereas EN 1149-3 is used when surface resistivity can not be used because the dissipation of charges is based on induction.

In addition to these test-method standards there is a further standard, EN 1149-5:2018[4] which provides the performance requirements for anti-static PPE.

**Notes:**

For the antistatic performance data relating to a particular product please refer to the relevant technical data.

[1]ATEX - The abbreviation derives from 'ATmosphères EXplosibles'. [2]Directive 2014/34/EU on equipment and protective systems intended for use in potentially explosive atmospheres. [3]Directive 99/92/EC Minimum requirements for improving the safety and health protection of workers potentially at risk from explosive atmospheres. [4]EN 1149 - 5:2018 Protective clothing with electrostatic properties.

APPENDIX 10

# Garment donning, doffing and adjustment

## The right size and usage of the garment

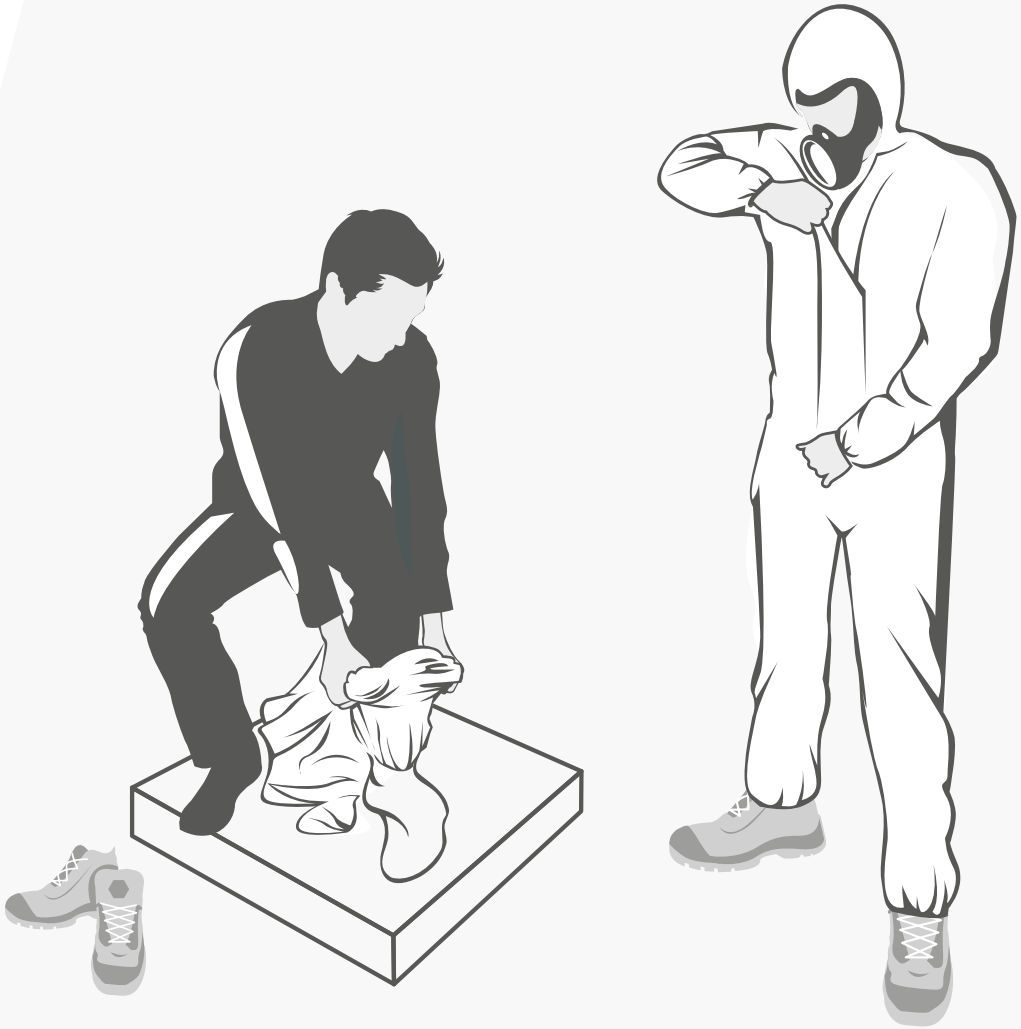
Choosing the correct size of garment is a prerequisite not just for greater safety but also for greater comfort. Choosing the wrong size can have fatal consequences; if it's too big it can get stuck in production machinery, if it's too small it can tear or considerably restrict mobility. It is important that a coverall is used that not only offers the correct protection but also fits the person properly.

For guidance on donning and doffing procedures please consult your supplier refer to the following videos.

- **Tyvek® 500 Xpert**
- **Tyvek® 800 J**
- **Tychem® 6000 F**
- **Tychem® 6000 AL - Donning**
- **Tychem® 6000 AL - Doffing**

### Training

A theoretical knowledge of how to don and doff a protective garment is no substitute for practice. It is important to remember that only people who have received specific training should be authorised to wear, remove and dispose of contaminated clothing.



APPENDIX 11

# Garment storage and expected life span

Good storage and maintenance will ensure that a protective garment performs as it should do at the time it is needed. Correct storage is an essential part of any PPE programme, whether the items are used being used daily or stored for future or emergency use. Inadequate or unduly prolonged storage conditions can directly affect a product's functional performance and provisions must always be made to ensure that adequate storage and renewal provisions are in place.

## Garment 'Shelf Life'

The 'shelf life' of a protective garment relates to it expected functional life under recommended storage conditions. It is the timespan during which a product can be used with its functional performance still intact. Different products and brands can have widely varying 'shelf lives' with some having a very limited shelf-life and others coming from suppliers that are unable to provide accurate product longevity data. This is very important, since a product with an expired shelf-life cannot be guaranteed to provide the level of wearer safety specified and their use could leave personnel with inadequate protection.

There is no official norm describing how shelf life of PPE should be determined and therefore specifiers and users must ALWAYS CHECK what manufacturer tests have been conducted and what data is available to support claims relating to product life expectancy.

## Garment storage and maintenance

Both garments in storage and garments in use must be stored correctly in accordance with manufacturer's recommendations. Typically this will require that they are kept in clean, dry, secure conditions at temperatures of between 10-25°C preferably in a dedicated and sealed container or locker to minimise the risks of tampering, unauthorised use, and inadvertent damage. Direct exposure to sunlight for prolonged periods must be avoided and garments must always be visually inspected for damage before wearing.

It is recommended that a nominated person is put in charge of storage and maintenance to ensure that the responsibility is not overlooked or carried our ineffectively. Employees should be educated in the correct use of all PPE and must be responsible for reporting any loss, fault or damage.

It is the employers responsibility to ensure that appropriate PPE is available at all times to employees. It is important that a PPE review, rotation and replacement programme is in place to check that protection is available and that it is within its designated shelf-life.

In the case of Tyvek® and Tychem® products, DuPont has based its recommendations for shelf life upon accelerated-ageing tests on fabric tensile properties. Different fabrics were aged using an ASTM 572-88 test modified to incorporate higher temperatures (100°C vs 70°C) and higher pressures (300 psi vs 100 psi), to provide a more rigorous evaluation. The results of this evaluation conclude that Tyvek® and Tychem® fabrics retain physical strength and barrier properties over following years:

| Fabric Type | Expected fabric shelf life (years) |
|---|---|
| Tychem® TK | 10 |
| Tychem® 6000 F | 10 |
| Tychem® 2000 C | 10 |
| Tychem® 4000 S | 5 |
| Tyvek® 600 Plus /500/400 | 10 |
| Tyvek® 800 J | 5 |
| Tyvek® IsoClean® non sterile | 10 |
| Tyvek® IsoClean® clean & sterile and sterile only | 5 |
| Tyvek® 500 AV/ES | 10 |
| ProShield® 60 | 3 |
| ProShield® 20 | 3 |
| ProShield® 20 SFR | 1,5 |

## Periodic garment testing

In the case of gas-tight suits it is recommended that regular pressure tests are carried out on at least annual intervals throughout the designated product life span. This applies whether the products are in use or in storage.

APPENDIX 12

# Garment disposal and end-of-life options

## Disposal and Recycling

For environmental and safety reasons it is important that users of protective clothing have a garment disposal and recycling programme in place. Many types of uncontaminated and unused garments can be recycled at standard recycling facilities. Contaminated coveralls should be treated as hazardous waste and be disposed of according to the nature of contamination and in accordance with national and local regulations. This will normally entail incineration or other approved method.

Tyvek® is a nonvowen sheet made of High Density Polyethylene (HDPE). It is produced by DuPont de Nemours Luxembourg S.à r.l. Under an environmental policy verified to ISO 14001. DuPont is comitted to the efficient utilisation of reutilisation of resources and collaborates with designers, converters, manufacturers and others to help them meet their sustainability goals.

**Notes:**

For safety reasons DuPont does not recommend the use of reuseable and launderable garments where a limited-use garment of equivalent or higher-performance is available.

**Most preferred option**

1. Virgin, unpigmented Tyvek® can be 100% recycled back into equivalent quality product with no loss of properties or functionality whatsoever. DuPont has been carrying out this recycling process at its manufacturing plants for several decades.
2. Using the right preparatory and processing equipment, used but uncontaminated Tyvek® can also be recycled at facilities accepting HDPE. Reclaimed material can be repurposed into new quality products such as garden furniture, milk crates, wall cladding, toys, refuse containers and waste pipes.
3. Subject to local regulations, contaminated Tyvek® can be safely incinerated and, under optimal conditions, will only release water and carbon dioxide, leaving no significant residues. It can be used a fuel yielding more than twice the energy value of coal , and as much energy as oil, in terms of BTU rating.
4. If recycling or incineration are not options, Tyvek® can be safely landfilled. Because it is chemically inert and contains no fillers, binders or additives, Tyvek® will not leach into groundwater nor release contaminants into the soil.

**Least preferred option**

**Figure 13** End-of-life options for Tyvek® products, **Source:** DuPont

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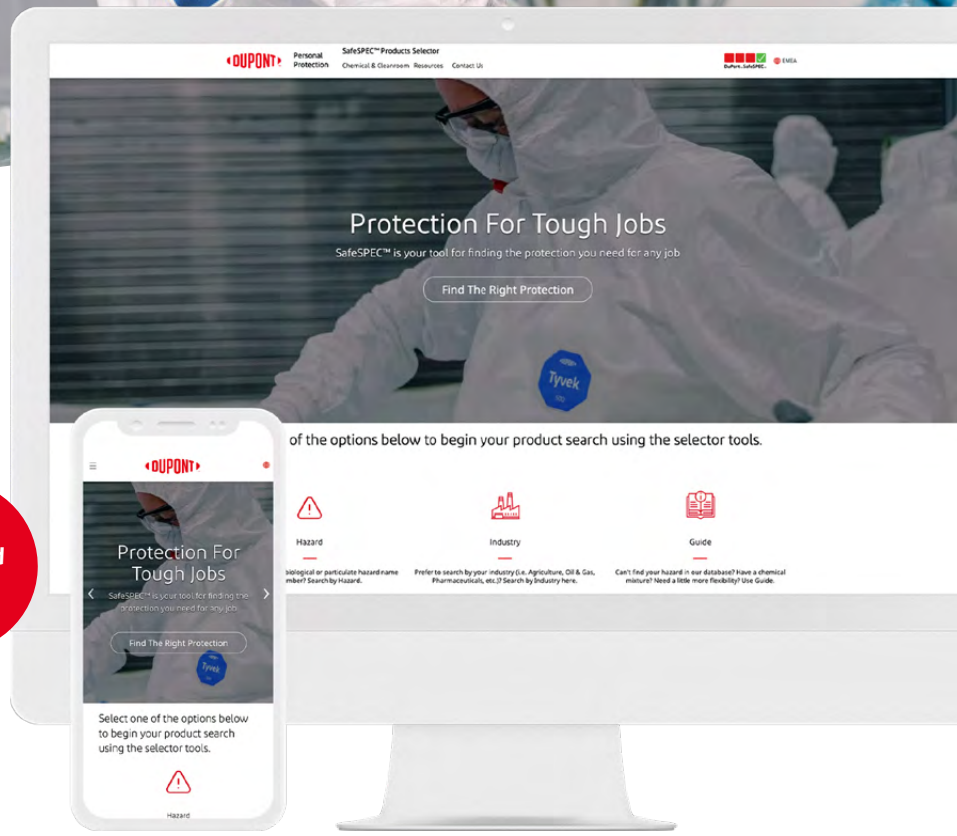


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