DUPONT PERSONAL PROTECTION

Product Catalogue

Tychem. Tyvek. ProShield.

Chemical Protective Solutions

CONTENT OVERVIEW

DEDICATED TO YOU – THE NEW PRODUCT CATALOGUE FROM DUPONT PERSONAL PROTECTION

Dedicated to safety
Dedicated to innovation
Dedicated to you...

Every day hundreds of DuPont engineers around the world are working hard to solve your problems. It's this strong customer focus that sets us apart and made us into one of the most trusted and respected brands in the field of personal protection.

At DuPont we are dedicated to providing high quality protective apparel. By listening to you, our customer, and responding to your needs, we work hard to maintain our position as a market leader in what we do best: designing and producing a comprehensive, exhaustively tested, and innovative range of quality single- and limited-use protective garments.

The right garment for you

Selecting the correct protective garment is rarely as simple as choosing from a table of options. There are many factors to consider and it is a careful analysis of these factors and their interrelationship that will determine the appropriate protection for a particular need. Every hazard scenario, every protection need and every single person is different so there is no one garment that is suitable for all circumstances. Which is why you will find such an extensive range of products and options in these pages.

Designed around your needs

In this new edition are some of the latest examples of our dedication to innovation and customer satisfaction. New materials, optimised designs and fit, and upgraded detailing are just some of the improvements you will find. In particular, we have been listening hard to your need for improved wearer comfort without compromising safety. Take a look at the innovative DuPont™ Tyvek® 800 J coverall on page 23 or the new Tychem® 4000 S garment on page 17. Both these products build on our barrier expertise and combine it with an entirely new experience in wearer comfort.

You are not alone...

If you need professional guidance on product selection and usage, or if you are setting up a worker protection programme, we are only a message or call away. We also have our free SafeSPEC™* selection aid – a user-friendly online tool which provides comprehensive information on the options available and assistance with the matching of protection to risk. And once you know what garments you require you won't have to go far to get what you need; our international dealer network provides local support and availability, all backed up by the global resources of DuPont.

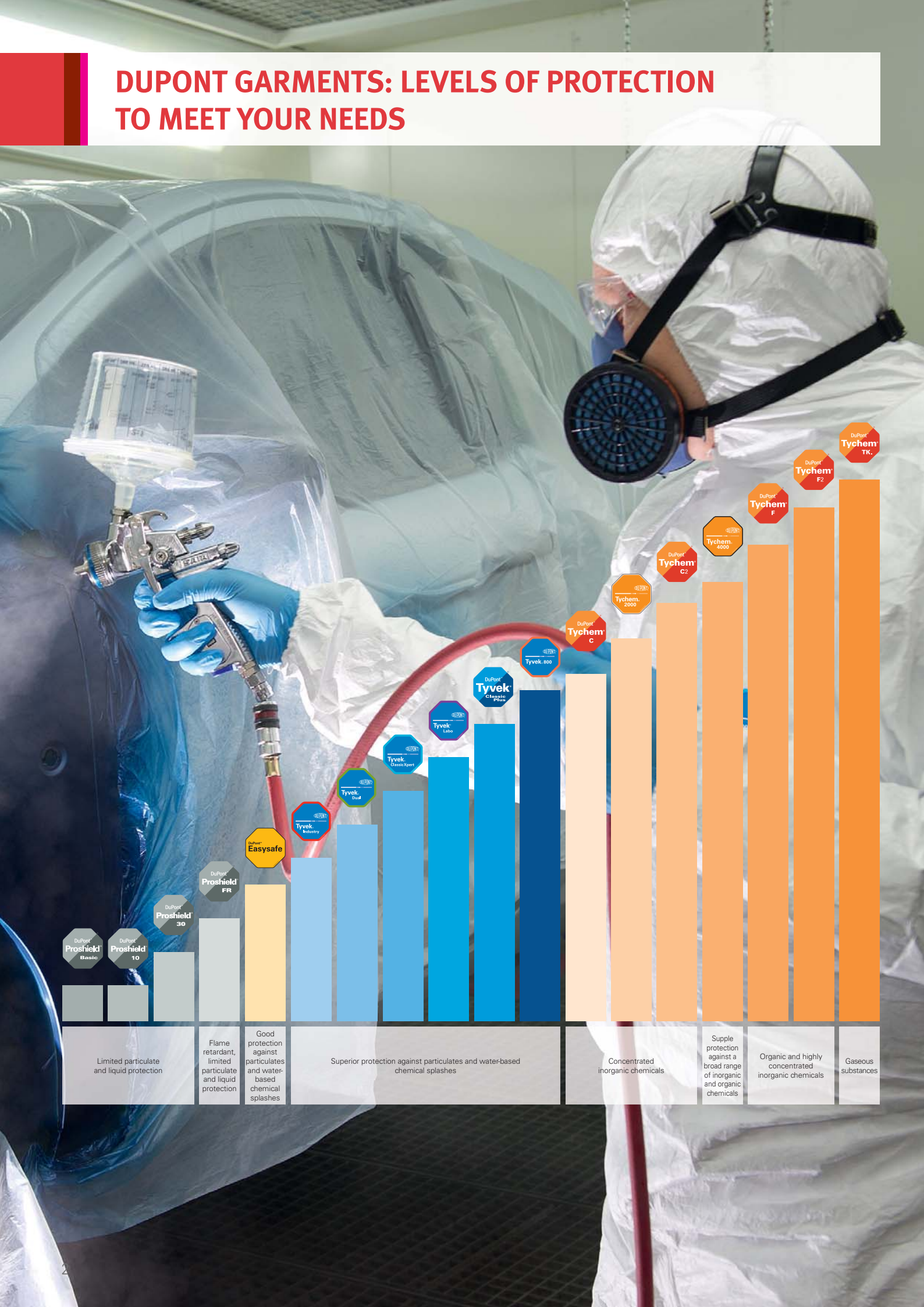
Count on us

With our uncompromising standards and commitment to safety, performance and quality we look forward to continuing to offer innovative solutions that are dedicated to your needs.

DuPont™ SafeSPEC™

*Go to www.safespec.dupont.co.uk

DUPONT GARMENTS: LEVELS OF PROTECTION TO MEET YOUR NEEDS



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. Additional information on CE marking can be found in Annexe 2.

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 below).
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'.

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** **TYPE 1 –** Protective clothing against liquid and gaseous chemicals, including liquid aerosols and solid particles. **TYPE 1 - ET –** Performance requirements for emergency teams.	EN 943-1:2002** EN 943-2:2002
TYPE 2	**Non-Gas-Tight** Protective clothing against liquid and gaseous chemicals, including liquid aerosols and solid particles.	EN 943-1:2002**
TYPE 3	**Liquid Tight** Protective clothing against liquid chemicals. Exposure to pressurised jet of liquid.	EN 14605:2005/A1:2009
TYPE 4	**Spray Tight** Protective clothing against liquid chemicals. Exposure to a liquid spray aerosol (unpressurised).	EN 14605:2005/A1:2009
TYPE 5	**Solid Particulates** Protective clothing against solid-airborne particulates.	EN ISO 13982-1:2004/A1:2010
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 13034:2005/A1:2009

* DuPont Pictogram. ** Amended in 2005.

Other Relevant Standards		
Pictogram	**Definition**	**Standard and Year***
**	Protective Clothing with Electrostatic properties – material performance and design requirements.	EN 1149-5:2008
***	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

* 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.

THE 9-STEP GUIDE FROM DUPONT TO GARMENT SELECTION

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.

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.

THE 9-STEP GUIDE FROM DUPONT TO GARMENT SELECTION

Step 1:
Hazard identification

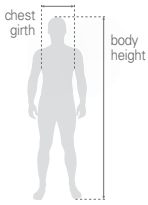
Step 2:
Determine minimum levels of protection needed

Step 3:
Assess hazard toxicity

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

ISO 14001
ISO 9001

Step 8:
Identify the correct usage of the product

TRY IT!

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.

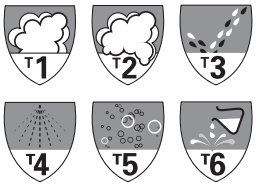
This risk analysis might take the following form:

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. For further details please refer to Annexe 1 and Annexe 2.

Step 3:
Assess hazard toxicity

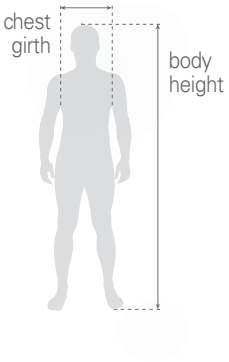
Warning

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. Detailed permeation data for over than 450 chemicals can be accessed on www.safespec.dupont.co.uk.

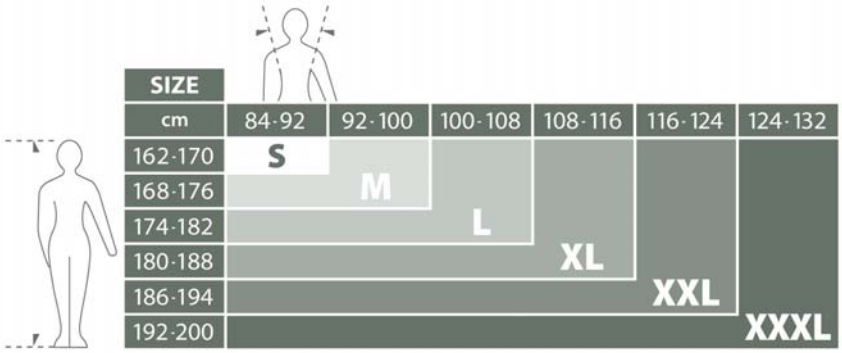
Step 4:
Determine protective performance requirements of the fabric and seam

When it comes to protective apparel, it is crucial to differentiate between penetration and permeation (please see Annexe 4 and refer to the DuPont Permeation Guide.) Penetration is the physical process whereby a liquid, vapour or gas passes through the material via 'pores' or 'holes' in the fabric. It is more relevant when referring to particle penetration of a fabric or whole suit. Permeation is the process by which a chemical, in the form of a liquid, vapour or gas, moves through protective clothing material on a molecular level. Garment protection performance, penetration and permeation is relevant for garment seams since a garment's protective ability cannot afford to be compromised by weak and pervious fabric joints. Therefore it is important to verify the seam performance in addition to the fabric performance (please see Annexe 4).

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 Annexe 6 and donning and doffing videos in Annexe 8). 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 6:
Comfort considerations (please see Annexe 6)

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

ISO 14001
ISO 9001

When evaluating protective garments on which the health and safety of workers depend it is important to take into account the manufacturer concerned'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.

Some additional questions you might ask potential suppliers include:

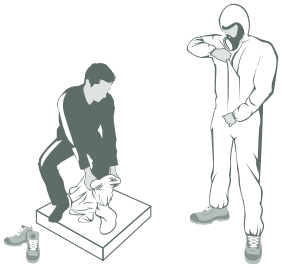
- ✓ Does the company offer Customer Service support (technical support hotline, customer focused websites and tools, wear trials)?
- ✓ Does the company offer open access to product data e.g. can the company provide comprehensive permeation data for its products?
- ✓ Can it demonstrate exemplary case 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?

At a product level the manufacturer should ensure that in addition to the highest standards of quality, the protective garments should be free from hazardous or banned ingredients, free from SVHC's (REACH compliant), not present hazards to the ecosystem and not include skin allergens or sensitisers. 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.

8

Step 8:

Identify the correct usage of the product (please see Annexe 2 and Annexe 3)



Ensure proper training is provided for correct donning, doffing and usage (please see Annexe 8) 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 see Annexe 1). Please make sure you answer the following questions:

- ✓ Is additional taping required e.g. to the mask, cuffs, ankles? (please see Annexe 5).
- ✓ Have earthing requirements been considered for the wearer and the coverall? (please see Annexe 7)
- ✓ 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? (please see videos in Annexe 8)

9

Step 9:

Wear test

TRY IT!

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

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.

DuPont™ SafeSPEC™ Active Assistance

DuPont™ SafeSPEC™

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. For details of the full DuPont range and for fabric permeation data go to **DuPont™ SafeSPEC™ Selector Tools** and see solutions proposed for your tasks, at www.safespec.dupont.co.uk.

www.safespec.dupont.co.uk

TYCHEM®

Tychem® is an innovative fabric range comprising multiple barrier layers that help provide protection from chemicals (even those under pressure), biohazards and particulates. Tychem® C coveralls feature a coated Tyvek® fabric and provide barrier protection against numerous concentrated inorganic chemicals and biological hazards. New, Tychem® 4000 S garments utilise a film laminated to Tyvek® fabric to achieve a barrier to permeation by a range of highly concentrated inorganic and certain organic chemicals. Tychem® F garments, also comprising a film laminated to Tyvek®, offer the broadest chemical barrier, helping to protect personnel against numerous toxic industrial organic chemicals, highly concentrated inorganic chemicals and chemical warfare agents.

TYCHEM® C

Category III | TYPE 3 -B | TYPE 4 -B | TYPE 5 -B | TYPE 6 -B | EN 1149-5 | EN 1073-2* Class 1 | EN 14126

Comfortable, lightweight protection against biohazards and inorganic chemicals

Benefits

- ✓ 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

Features

Hooded coverall. Elasticated face, wrists, waist and ankles for an optimal fit, thumb loops prevent sleeves from riding up. Self-adhesive chin flap for tight seal of suit to face-masks.

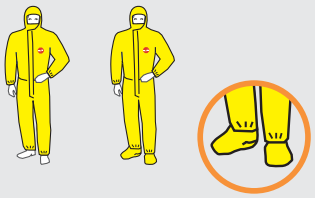
Applications

Tychem® C is used for splash or pressurised splash protection in a variety of industrial environments, including pulp and paper manufacturing, food processing, chemical processing and pharmaceutical manufacturing.

* Does not protect against ionizing radiation.

Product detail

Colour/Reference:
Model CHA5, Yellow: TYC CHA5 T YL 00
Model CHA6, Yellow (with socks): TYC CHA5 T YL 16*



SIZE: S to XXXL
SIZE: M to XXXL*

TYCHEM® 2000 C

Category III | TYPE 3 -B | TYPE 4 -B | TYPE 5 -B | TYPE 6 -B | EN 1149-5 | EN 1073-2* Class 1 | EN 14126

Comfortable lightweight protection against biohazards and inorganic chemicals in an IMPROVED design

NEW!

Benefits

- ✓ Double zip and double flaps permit limited re-use if not contaminated
- ✓ Double cuff system for good glove compatibility**
- ✓ Protective seams, stitched and over-taped with barrier-tape, providing barrier performance equal to that of the fabric
- ✓ Ergonomic fit helps wearers to handle tasks more easily and comfortably

Features

Hooded coverall. Tunnelled elastics at face, wrists, waist and ankles for an optimal fit, thumb loops at sleeves prevent them from riding up. Self-adhesive chin flap for tight seal of suit to face-masks.

Applications

Tychem® 2000 C is used for splash or pressurized splash protection in a variety of industrial environments, including pulp and paper manufacturing, food processing, chemical processing and pharmaceutical manufacturing.

* Does not protect against ionizing radiation.
** Cuffs recommended to be taped to gloves for a tight seal.

Product detail

Colour/Reference:
Model CHZ5, Yellow: TC CHZ5 T YL 00

SIZE: S to XXXL

TYCHEM® C2

Category III | TYPE 3 -B | TYPE 4 -B | TYPE 5 -B | TYPE 6 -B | EN 1149-5 | EN 1073-2* Class 1 | EN 14126

Combining high mechanical strength and protection against a range of inorganic chemicals and biological hazards

Benefits

- ✓ Barrier of a Tychem® C fabric with higher mechanical strength
- ✓ Protective seams, stitched and over-taped with barrier-tape, providing barrier performance equal to that of the fabric
- ✓ Double zip and double flaps permit limited re-use if not contaminated
- ✓ Double cuff system for good glove compatibility**

Features

Hooded coverall. Elasticated face, wrists, waist and ankles for an optimal fit, including use of a comfort elastic at the wrists and face to avoid skin irritation. Self-adhesive flap for tight seal of suit to face-masks.

Applications

Tychem® C2 is used for splash or pressurised splash protection in a variety of demanding industrial environments, including pulp and paper manufacturing, shutdowns, chemical processing and pharmaceutical manufacturing.

* Does not protect against ionizing radiation.
** Cuffs recommended to be taped to gloves for a tight seal.

Product detail

Colour/Reference:
Model CHZ5, Yellow: TC2 CHZ5 T YL 00

SIZE: M to XXXL

TYCHEM® C ACCESSORIES

Tychem® C accessories in combination with chemical protective clothing can offer enhanced protection of body parts that are more exposed to hazardous substances

	Product description	CE Category & Type	Reference
	**Tychem® C gown, model PL50** Shin-length gown with wrap-over rear closure, hook and loop neck closure and waist ties. Elasticated wrists. Available in yellow and sizes S/M and L/XXL.	Cat. III Type PB [3]*	TYC PL50 S YL 00
	**Tychem® C apron, model PA30L0** Shin-length apron with neck and waist ties. Available in yellow and in one size.	Cat. III Type PB [3]*	TYC PA30 S YL 00
	**Tychem® C sleeve, model PS32LA** 50 cm long and with wide elastics at cuffs and upper arm. Available in yellow and in one size.	Cat. III Type PB [3]*	TYC PS32 S YL 00
	**Tychem® C overboot, model POBA** Knee-length overboot with slip-retardant sole. Fixation ties. Sole is partially stitched: splash-proof, not fully liquid tight. Available in yellow and in one size.	Cat. III Type PB [3]*	TYC POBA S YL 00

* Partial body protection.

TYCHEM® 4000 S

Category III | TYPE 3-B | TYPE 4-B | TYPE 5-B | TYPE 6-B | EN 1149-5* | EN 1073-2** Class 1 | EN 14126

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

NEW!

Benefits

- ✓ 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

Features

Hooded coverall. Elasticated face, wrists, waist and ankles for an optimal fit, thumb loops to prevent sleeves from riding up. Self-adhesive chin flap for tight seal of suit to face-mask.

Applications

Tychem® 4000 S is ideal for chemical handling, environmental clean-up operations and emergency response. It is suitable for use in a variety of industries, including oil and gas, chemical engineering, and for use by hazardous material response teams and other emergency services.

* Please see instructions for use for details.
** Does not protect against ionizing radiation.
*** Cuffs recommended to be taped to gloves for a tight seal.

Product detail

Colour/Reference:
Model CHZ5, White: SL CHZ5 T WH 00
Model CHZ6, White (with socks): SL CHZ6 T WH 16

SIZE: S to XXXL

TYCHEM® F

Category III | TYPE 3 -B | TYPE 4 -B | TYPE 5 -B | TYPE 6 -B | EN 1149-5 | EN 1073-2* Class 1 | EN 14126

Trusted protection against a broad range of chemicals and biohazards

Benefits

- ✓ Protection against numerous toxic industrial organic chemicals, highly 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

Features

Hooded coverall. Elasticated face, wrists, waist and ankles for an optimal fit, thumb loops prevent sleeves from riding up. Self-adhesive chin flap for tight seal of suit to face-masks.

Applications

Tychem® F is used for a broad range of applications from chemical spill clean-up, emergency response, to military and petrochemical applications.

* Does not protect against ionizing radiation.

Product detail

Colour/Reference:
Model CHA5, Grey: TYF CHA5T GY 00
Model CHA5, Orange: TYF CHA5T OR 00*
Model CHA6, Grey (with socks): TYF CHA5T GY 16**

SIZE: S to XXXL
SIZE: M to XXL*
SIZE: M to XXXL**

TYCHEM® F2

Category III | TYPE 3 -B | TYPE 4 -B | TYPE 5 -B | TYPE 6 -B | EN 1149-5 | EN 1073-2* Class 1 | EN 14126

Comprehensive Tychem® F protection combined with even higher mechanical strength

Benefits

- ✓ Barrier of a Tychem® F fabric with higher mechanical strength
- ✓ Protective seams, stitched and over-taped with barrier-tape, providing barrier performance equal to that of the fabric
- ✓ Double zip and double flaps permit limited re-use if not contaminated
- ✓ Double cuff system for good glove compatibility**

Features

Hooded coverall. Elasticated face, wrists, waist and ankles for an optimal fit, including use of a comfort elastic at the wrists and face to avoid skin irritation. Self-adhesive flap for tight seal of suit to face-masks.

Applications

Tychem® F2 is used for splash or pressurised splash protection in a variety of demanding industrial environments, including pulp and paper manufacturing, shutdowns, chemical processing and pharmaceutical manufacturing. It can be used across a broad range of applications, from chemical spill clean-up, emergency response, to military and petrochemical applications.

* Does not protect against ionizing radiation.
** Cuffs recommended to be taped to gloves for a tight seal.

Product detail

Colour/Reference:
Model CHZ5, Grey: TF2 CHZ5 T GY 00

SIZE: M to XXXL

TYCHEM® F ACCESSORIES

Tychem® F accessories in combination with chemical protective clothing can offer enhanced protection of body parts that are more exposed to hazardous substances

	Product description	CE Category & Type	Reference
	**Tychem® F gown, model PL50** Shin-length gown with wrap-over rear closure, hook and loop neck closure and waist ties. Elasticated wrists. Available in grey and sizes S/M and L/XXL.	Cat. III Type PB [3]*	TYF PL50 S GY 00
	**Tychem® F apron, model PA30L0** Shin-length apron with neck and waist ties. Available in grey and in one size.	Cat. III Type PB [3]*	TYF PA30 S GY 00
	**Tychem® F sleeve, model PS32LA** 50 cm long and with wide elastics at cuffs and upper arm. Available in grey and in one size.	Cat. III Type PB [3]*	TYF PS32 S GY 00
	**Tychem® F overboot, model POBA** Knee-length overboot with slip-retardant sole. Fixation ties. Sole is partially stitched: splash-proof, not fully liquid tight. Available in grey and in one size.	Cat. III Type PB [3]*	TYF POBA S GY 00

* Partial body protection.

TYCHEM® TK.

Category III TYPE 1a -ET

Exceptional protection against a broad range of toxic, corrosive gases, liquids and chemicals

Benefits

- ✓ Limited-life, gas-tight suit for use with self-contained breathing apparatus
- ✓ High-level protection against a broad range of toxic, corrosive gases, liquid and solid chemicals according to EN 943-2
- ✓ Alternative to conventional reusables and is lightweight, easy-to-wear and supple
- ✓ Option: Attached hazmat chemical boots

Features

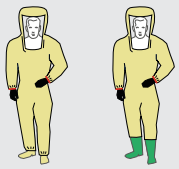
Gas-tight suit with attached boots or socks. Encapsulated gas-tight garment, with detachable Hazmat boots that is both robust and lightweight (<4.6 kg per garment). Wide, anti-mist visor for undistorted, panoramic visibility. Bat-wing design to allow the wearer to withdraw an arm to attend to breathing apparatus. Internal, adjustable waist belt system for support and improved fit. Five-finger, dual-glove assembly with locking cuff mechanism for glove replacement.

Applications

The Tychem® TK. garment is specifically developed for protection against toxic, corrosive gases, liquids and solid chemicals and is suited for industrial, hazmat and domestic preparedness applications.

Product detail

Colour/Reference:
Tychem® TK., Lime green: TYK GEVJD YL 00 Socks/Boots



SIZE: S to XXXL

TYVEK®

Tyvek® is a unique nonwoven fabric that comes with inherent protection that's engineered right in. Designed for an optimal balance of protection, durability and comfort, Tyvek® protective apparel is ideal for a wide range of jobs. From spray painting to handling lead or asbestos abatement, the ergonomic design helps keep workers safe and effective when the going gets rough. It is also devoid of fillers or additives and is silicon-free.

TYVEK® 800 J

Category III | TYPE 3 -B* | TYPE 4 -B | TYPE 5 -B | TYPE 6 -B | EN 1149-5 | EN 1073-2** Class 2 | EN 14126

The new, breathable Type 3 garment for protection against water-based inorganic chemicals under pressure

NEW!

Benefits

- ✓ 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

Features

Hooded coverall. Robust yet lightweight (<300 g per garment). Self-adhesive zipper flap. Self-adhesive chin flap for tight seal of suit to mask. Elasticated face, wrists and ankles as well as glued-in waist elastic. Thumb loops to prevent sleeves from riding up.

Applications

Applications for Tyvek® 800 J garments include those in very humid applications requiring chemical, liquid protection and/or oil repellency. Typical activities include industrial cleaning, mining, work at petrochemical installations, in sewers and maintenance operations.

* Please see instructions for use for details.
** Does not protect against ionizing radiation.

Product detail

Colour/Reference:
Model CHA5, White: TJ CHA5 T WH 00

SIZE: S to XXXL

TYVEK® CLASSIC PLUS

Category III | TYPE 4 -B | TYPE 5 -B | TYPE 6 -B | EN 1149-5 | EN 1073-2* Class 2 | EN 14126

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

Benefits

- ✓ 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

Features

Hooded coverall. Robust yet lightweight (<250 g per garment). Self-adhesive chin flap for tight seal of suit to the mask. Elasticated face, wrists and ankles as well as glued-in waist elastic. Elasticated thumb loops prevent sleeves from riding up. Chemical permeation of coloured Tyvek® is not identical to that of white Tyvek®. Please refer to permeation data.

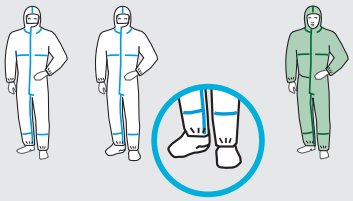
Applications

Applications for Tyvek® Classic Plus garments include maintenance and dismantling jobs in the nuclear industry, pharmaceutical manufacturing or in research and biosecurity laboratories, as well as in medical applications and when exposed to biological hazards.

* Does not protect from ionizing radiation.

Product detail

Colour/Reference:
Model CHA5a, White: TYV CHA5 T WH 00
Model CHA6, White (with socks): TYV CHA5 T WH 16
Model CHA5a, Green: TYV CHA5 T GR 00*



SIZE: S to XXXL
SIZE: M to XXL *

TYVEK® CLASSIC XPERT

Category III | TYPE 5-B | TYPE 6-B | EN 1149-5 | EN 1073-2* Class 2 | EN 14126

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

Benefits

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

Features

Hooded coverall. Robust yet lightweight (<180 g per garment). 3-piece hood for optimal fit to head and face when turning. Elasticated face, wrists and ankles as well as glued-in waist elastic. Ample crotch area for freedom of movement. Large, easy-to-grasp zipper puller. Chemical permeation of coloured Tyvek® is not identical to that of white Tyvek®. Please refer to permeation data.

Applications

Applications for Tyvek® Classic Xpert garments include those found in pharmaceutical handling, chemical processing, the oil and gas industry, mining, general maintenance and operations, automatic spray painting and many others.

* Does not protect against ionizing radiation.

Product detail

Colour/Reference:
Model CHF5, White: TYV CHF5 S WH 00
Model CHF5a, Green: TYV CHF5 S GR 00*
Model CHF5a, Blue: TYV CHF5 S BU 00*

SIZE: S to XXXL
SIZE: M to XXL *

TYVEK® LABO

Category III | TYPE 5 | TYPE 6 | EN 1149-5* | EN 1073-2** Class 2

Protecting wearers and processes in laboratories and clean environments

Benefits

- ✓ Protects 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

Features

Hooded coverall with attached, slip-retardant overshoes. Robust yet lightweight (<250 g per garment). 3-piece hood and gusset for improved fit. Elasticated face, wrists and ankles as well as glued-in waist elastic.

Applications

Applications include the pharmaceutical industry, laboratories, cosmetics, optical and electronics.

* Please see instructions for use for details.
** Does not protect from ionizing radiation.

Product detail

Colour/Reference:
Model CHF7, White: TYV CHF7 S WH 00

SIZE: S to XXXL

TYVEK® INDUSTRY

Category III | TYPE 5 | TYPE 6 | EN 1149-5 | EN 1073-2* Class 1

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

Benefits

- ✓ 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

Features

Coverall with collar. Robust yet lightweight coverall (<180 g per garment). Elasticated wrists, waist and ankles. Gusset for improved fit.

Applications

This garment is ideal for workers in pharmaceutical, medical device, biotech and electronic settings that require high standards for particle and microbiological contamination control.

* Does not protect from ionizing radiation.

Product detail

Colour/Reference:
Model CCF5, White: TYV CCF5 S WH 00

SIZE: S to XXXL

TYVEK® DUAL

Category III | TYPE 5 | TYPE 6 | EN 1149-5 | EN 1073-2* Class 1

Protection and durability where it's needed, breathability where it's not

Benefits

- ✓ 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

Features

Hooded coverall. 3-piece hood and gusset for optimal fit. Elasticated face, wrists, waist and ankles. The large, breathable back panel, made of SMS nonwoven, offers lower protection against particles (down to 3 microns in size) and light water-based splashes, yet high levels of comfort.

Applications

Tyvek® Dual is designed for specific applications that demand comfort while helping to provide protection from frontal exposure during brick ceramic firing, foundries and smelting operations, paint spraying or any work involving composite materials, glass manufacturing, and utilities.

* Does not protect from ionizing radiation.

Product detail

Colour/Reference:
Model CHF5, White: TYV CHF5A S WH 00

SIZE: S to XXXL

TYVEK® ACCESSORIES

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

	Product description	Reference
	**Tyvek® labcoat, model PL30** Labcoat with collar, available in white and in sizes M to XXL. 5 press stud closures. 3 pockets. Stitched internal seams.	TYV PL30 S WH 00
	**Tyvek® labcoat, model PL30NP** Labcoat with collar, available in white and in sizes M to XXL. 5 press stud closures. Without pockets. Elasticated cuffs (not tunnelled). Stitched internal seams.	TYV PL30 S WH NP
	**Tyvek® labcoat, model PL309** Labcoat with collar, available in white and in sizes S to XXL. Zipper closure. 2 pockets. Elasticated cuffs (tunnelled). Stitched internal seams.	TYV PL30 S WH 09
	**Tyvek® apron, model PA30L0** Shin-length apron with neck and waist ties. Available in white and in one size (length 108 cm).	TYV PA30S S WH L0
	**Tyvek® jacket with hood, model PP33** Hooded jacket available in white and in sizes M to XXL. Zipper closure. Stitched internal seams.	TYV PP33 S WH 00

All Tyvek® accessories are supplied with an antistatic treatment.

TYVEK® ACCESSORIES

	Product description	Reference
	**Tyvek® trousers, model PT31L0** Trousers available in white and in sizes M to XXL. Without pockets. Elasticated waist, no elastic at ankles. Stitched internal seams.	TYV PT31 S WH L0
	**Tyvek® hood, model PH30L0** Hood with flange and elasticated face and neck. Available in white and in one size.	TYV PH30 S WH L0
	**Tyvek® sleeve, model PS32LA** 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.	TYV PS32 S WH LA
	**Tyvek® overboot, model POBO** Knee-length overboot available in white and in one size. Elasticated top and fixation ties. Stitched internal seams.	TYV POBO S WH 00
	**Tyvek® overboot, model POBA** Knee-length overboot available in white and in one size. Elasticated top and fixation ties. Stitched internal seams. Slip-retardant sole.	TYV POBA S WH 00
	**Tyvek® overshoe, model POS0** Overshoe available in white and in one size (38 cm long). Elasticated ankle. Stitched internal seams.	TYV POS0 S WH 00
	**Tyvek® overshoe, model POSA** Overshoe available in white and in sizes 36 to 42 and 42 to 46. Elasticated ankle. Stitched internal seams. Slip-retardant sole.	TYV POSA S WH 00

All Tyvek® accessories are supplied with an antistatic treatment.

DUPONT™ EASYSAFE

Category III | TYPE 5 | TYPE 6 | EN 1149-5

Great breathability and optimised protection for less demanding applications

NEW!

Benefits

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

Features

Hooded coverall. Robust yet lightweight (<180 g per garment). 2-piece hood. Elasticated face, wrists, waist and ankles.

Applications

DuPont™ Easysafe applications include low level pharmaceutical needs, remediation and industrial cleaning and general manufacturing.

Product detail

Colour/Reference:
Model CHF5, White: TYR CHF5 S WH DE

SIZE: S to XXXL

ProShield®

PROSHIELD®

The ProShield® range, based on SMS or microporous film technology, is engineered for applications that require lower levels of protection. ProShield® garments are affordable and extremely practical, providing a new dimension in comfort at a limited level of protection.

PROSHIELD® FR

Category III | TYPE 5 | TYPE 6 | EN 1149-5 | EN 1073-2* Class 1 | EN ISO 14116** INDEX 1

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

Benefits

- ✓ 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 conform to reach compliance
- ✓ Antistatic treatment on both sides***

Features

Hooded coverall. 3-piece hood and 3-piece gusset for optimal fit. Elasticated face, wrists, waist and ankles. Generous fit offering high freedom of movement when wearing Index 2 or 3 flame-retardant workwear beneath.

Applications

ProShield® FR garments are used across a range of applications, including those in the petrochemical and railway industries, welding, gas and metal applications and certain Ex-Zones (refer to instructions for use).

Note:
An Index 1 garment should never be worn in direct contact to the skin, but on top of an Index 2 or Index 3 garment.

* 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® FR to 18 months.

Product detail

Colour/Reference:
Model CHF5, White with orange seams***: PFR CHF5 S WH 00

SIZE: M to XXXL

PROSHIELD® 30

Category III | TYPE 5 | TYPE 6 | EN 1149-5 | EN 1073-2* Class 1

Based on Microporous Film Laminate technology, ProShield® 30 offers high repellency to liquids

Benefits

- ✓ Good liquid repellency
- ✓ Medium durability
- ✓ Water vapour permeable

Features

Hooded coverall. 3-piece hood and 3-piece gusset for optimal fit. Elasticated face, wrists, waist and ankles.

Applications

ProShield® 30 garments are an ideal choice for applications that are less demanding in terms of barrier, durability and comfort, for example general maintenance, hospitals and other industries.spraying or any work involving composite materials, glass manufacturing, and utilities.

* Does not protect from ionizing radiation.

Product detail

Colour/Reference:
Model CHF5a, White: S30 CHF5 S WH 00

SIZE: S to XXXL

PROSHIELD® 10

Category III | TYPE 5 | TYPE 6 | EN 1149-5 | EN 1073-2* Class 1

Based on SMS technology, ProShield® 10 combines limited particle protection with high comfort level

Benefits

- ✓ Based on SMS Technology
- ✓ Limited particle protection

Features

Hooded coverall. 3-piece hood for optimal fit. Elasticated face, wrists, waist and ankles.

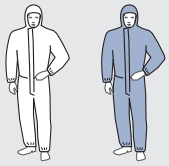
Applications

ProShield® 10 garments are an ideal choice for workers in warm applications, general maintenance, hospitals and other industries.

* Does not protect from ionizing radiation.

Product detail

Colour/Reference:
Model CHF5a, White: S10 CHF5 S WH 00
Model CHF5a, Blue: S10 CHF5 S BU 00



SIZE: S to XXXL

PROSHIELD® BASIC

Category III | TYPE 5 | TYPE 6 | EN 1149-5 | EN 1073-2* Class 1

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

Benefits

- ✓ Limited particle protection
- ✓ High comfort level: high air and water vapour permeability

Features

Hooded coverall. 2-piece hood. Elasticated face, wrists, waist and ankles. ProShield® Basic garments, made with SMS fabric, help combine low particle protection with high levels of comfort.

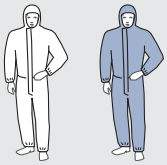
Applications

Ideal choice for workers seeking protection against dirt and grime in warm applications, general maintenance, hospitals and other industries.

* Does not protect from ionizing radiation.

Product detail

Colour/Reference:
Model CHF5, White: PB CHF5 S WH 00
Model CHF5, Blue: PB CHF5 S BU 00



SIZE: S to XXXL

WORKWEAR

Versatile and durable workwear from DuPont for non-hazardous applications. These garments do not comply with category III CE certification and therefore do not constitute chemical protective clothing.

PROSHIELD® PROPER

Category I

Benefits

- ✓ A versatile ultra-tough protective garment 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

Features

Coverall with mandarin collar. Two thigh pockets. Wrist and back elastication for good fit, open ankles (not elasticated).

Applications

ProShield® Proper coveralls are ideal workwear for do-it-yourself, general maintenance and cleaning, manufacturing and other non-hazardous applications as well as a semi re-usable garment for visitors.

Product detail

Colour/Reference:
Model CCF5, Grey: PRF CCF5 S GY 00

SIZE: S to XXL

PROSHIELD® PRACTIK

Category I

Benefits

- ✓ Micro-perforated non-woven polyethylene fabric allows unrestricted passage of air and water vapour. Antistatic treated on the inside (for comfort)
- ✓ Versatile protective garment for non-hazardous substances

Features

Hooded coverall. Elasticated face, wrists, waist and ankles.

Applications

ProShield® Practik coveralls are ideal workwear for do-it-yourself, general maintenance and cleaning, manufacturing and other non-hazardous applications.

Product detail

Colour/Reference:
Model CHO5, White: TYP CHO5 S WH 00

SIZE: M to XXL

PROSHIELD® POLYCLEAN

Benefits

- ✓ Coverall for use in non-hazardous applications
- ✓ Made of nonwoven polypropylene fabric (50 g/m^2)

Features

Hooded coverall. Face, wrist and ankle elastication for good fit. Purple seams for visual identification.

Applications

ProShield® Polyclean coveralls are ideal workwear for do it yourself, general maintenance and cleaning, manufacturing and other non-hazardous applications.

Product detail

Colour/Reference:
Model CHF5, White: P50 CHF5 S WH 00

SIZE: M to XXL

TEMPRO

Benefits

- ✓ Protection against dirt, grime and non-hazardous particles and aerosols
- ✓ Highly breathable limited flame-spread garment (tested according to EN ISO 15025 method A) to be worn over primary thermal protection

Features

Hooded coverall. Lightweight (<250 g per garment). Face, wrist and ankle elastication for good fit. Tempro is designed to provide limited protection against flame spread (Index 1) and must be worn over primary thermal protection such as DuPont™ Nomex®.

Applications

Tempro garments are an excellent choice for applications such as those found in steel mills, coal mines, maintenance work, refineries, laboratories and utilities.

Note:
This garment is only recommended to prevent stains of non hazardous products. Be careful: this garment does not comply with the category III CE certification. It is not chemical protective clothing. An Index 1 garment should never be worn in direct contact to the skin, but on top of an Index 2 or Index 3 garment. Unsuitable for usage in Ex-Zones.

Product detail

Colour/Reference:
Model TM127, Blue: TM 127 S BU 00

SIZE: M to XXXL

ANNEXE 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 Annexe 2).

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 wideranging 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 Annexe 5 - 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 underlying EU legislation in the form of Directive 89/686/EEC makes these limitations abundantly clear and in its own words says that the Directive 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 33 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.

[1] For a comprehensive exposition and clarification on PPE Directive 89/686/EEC please refer to: *Guidelines on the Application of Council Directive 89/686/EEC of 1 December 1989 on the Approximation of the Laws of the Member States Relating to Personal Protective Equipment Version(2010).*

ANNEXE 1:
CE MARKINGS, EUROPEAN STANDARDS AND LEGISLATIVE FRAMEWORK

MANDATORY STANDARDS

EU directives such as Council Directive 89/686/EEC[1] governing personal protective equipment that is placed on the market, are required to be embraced by member EU and EEC member companies 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 such as this tends to be wide in nature and in the case of 89/686/EEC 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 Annexe 7. 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. http://www.hse.gov.uk/foi/internalops/oms/2009/03/om200903app7.pdf).

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.

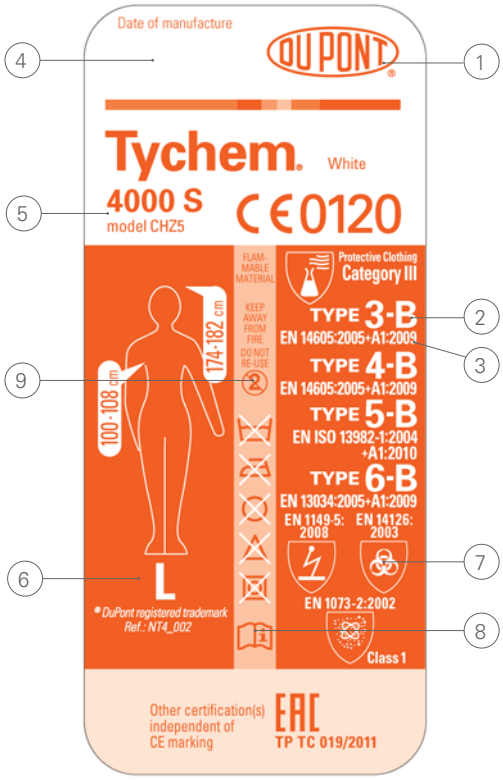
QUALITY CONTROL

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.

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).



'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.

ANNEXE 2:
PROTECTIVE GARMENTS – CATEGORIES, TYPES AND CLASSES

In accordance with European Directive EC 89/656[1], 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: ▶

Table 1. Risk assessment determines required garment performance.

Level of exposure	→	Garment type* - please see Annexe 5
Hazard/toxicity	→	Fabric barrier properties* - please see Annexe 3
Level of exposure	→	Mechanical fabric properties - please see Annexe 3

* Garment Type is linked to fabric barrier properties.

THE RELATIONSHIP BETWEEN GARMENT CATEGORIES, TYPES AND CLASSES

GARMENT 'CATEGORIES'

The European PPE directive 89/686/EEC[2] refers 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 Article 10 of the PPE Directive, 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 Article 11 of the PPE Directive. Note that all Category III PPE must be identified with the digit code of the notified body appended to the CE mark. ▼

Table 2. Categories of PPE and compliance with garment performance requirements.

PPE Category (89/686/EEC directive)	Definition	Logo	Initial EC-Type Certification from a notified body (Article 10*)	Manufacturer's declaration of Confirmity (Article 12*)	Annual Quality Surveillance Certification by a notified body (Article 11*)
Category III (PPE of complex design)	Protection against high risks where the employee can be exposed to elements which would be harmful to life e.g. chemical liquid exposure, asbestos and similar particulate hazards.	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 XXXX **	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

* European PPE directive 89/686/EEC. ** Represents the 4 digit numeric code of the notified body.

[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*, (http://eur-lex.europa.eu/legal-content/EN/TXT/? uri=CELEX:01989L0656-20070627 1989.)
[2] European Commision online, *Council Directive 89/686/EE on Personal Protective Equipment*, (http://eur-lex.europa.eu/ legal-content/EN/TXT/PDF/?uri=CELEX:01989L0686-20130101&from=EN 2013).

GARMENT TYPES

To facilitate the selection of Category III protective clothing the EU PPE Directive has broken Category III down into six levels of protection ('Types') with each Type being associated with a defined 'level of exposure'. 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 Annexe 3). 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 3. 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** **TYPE 1** – Protective clothing against liquid and gaseous chemicals, including liquid aerosols and solid particles. **TYPE 1 - ET** – Performance requirements for emergency teams.	EN 943-1:2002** EN 943-2:2002
 TYPE 2	**Non-Gas-Tight** Protective clothing against liquid and gaseous chemicals, including liquid aerosols and solid particles.	EN 943-1:2002**
 TYPE 3	**Liquid Tight** Protective clothing against liquid chemicals. Exposure to pressurised jet of liquid.	EN 14605:2005/A1:2009
 TYPE 4	**Spray Tight** Protective clothing against liquid chemicals. Exposure to a liquid spray aerosol (unpressurised).	EN 14605:2005/A1:2009
 TYPE 5	**Solid Particulates** Protective clothing against solid-airborne particulates.	EN ISO 13982-1:2004/A1:2010
 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 13034:2005/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 4. Other relevant PPE standards.

Other Relevant Standards		
Pictogram	**Definition**	**Standard and Year***
**	Protective Clothing with Electrostatic properties – material performance and design requirements.	EN 1149-5:2008
***	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

* 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.

NOTES

For information on radioactive particulate protection please see Annexe 5.

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 Annexe 4). 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.

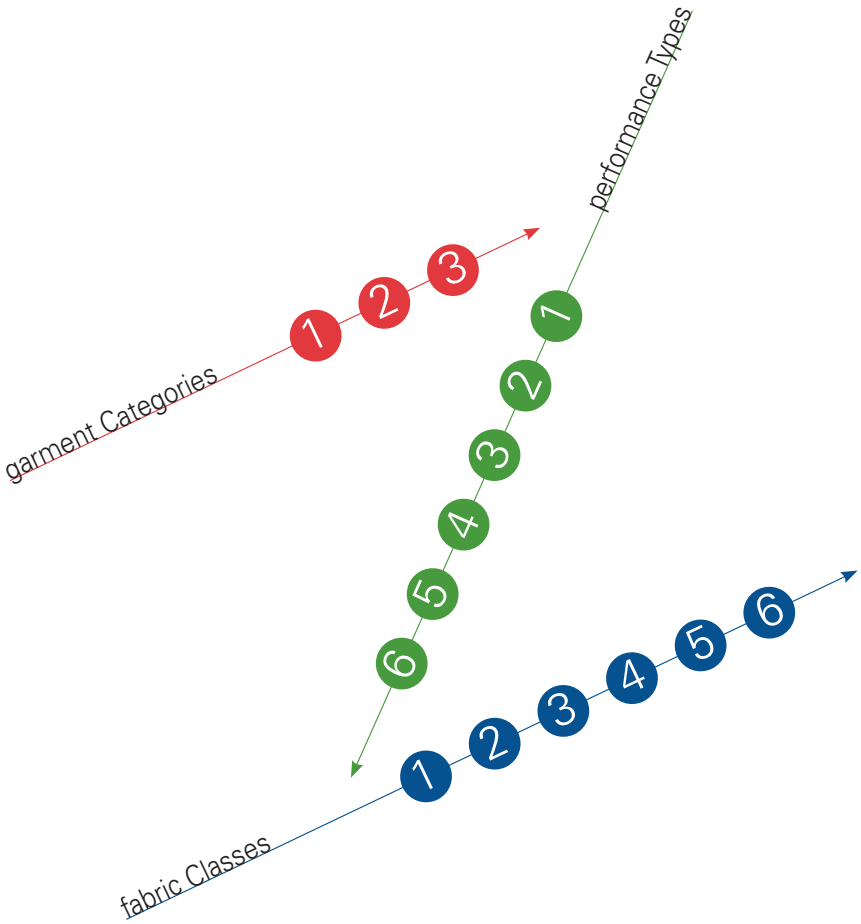
Table 5. Mechanical performance tests.

	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 textile 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 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 toi 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.

ANNEXE 3:
FABRICS - TYPES AND PROPERTIES

Some of the physical properties of PPE fabrics are categorised under the fabric Classes mentioned in Annexe 2. Whole garment performance is covered in Annexe 5. For information on fabric test methods please see Annexe 4.

DIFFERENT 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 Annexe 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. ▼

Informational properties

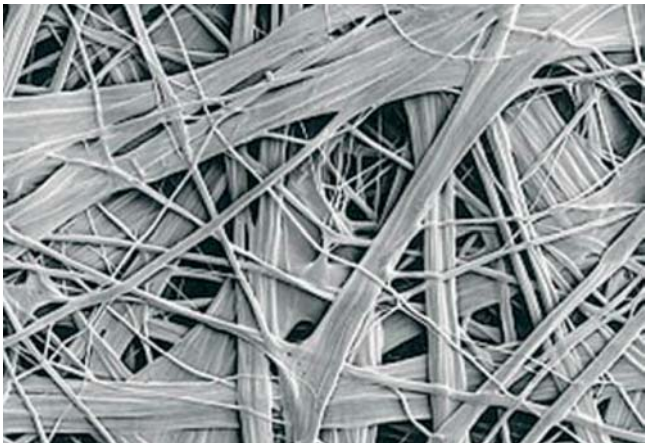
Basis weight	EN ISO 536	g/m²
Thickness	EN ISO 534	µm
Resistance to water penetration	EN 20811	cm H_2O
Bursting strength	ISO 2758	kPa
Air permeability (Gurley)	ISO 5636-5	s
Water vapour resistance, Ret	EN 31092	m².Pa/W

Table 6. 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

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. ▶



1:500 **Source:** DuPont.

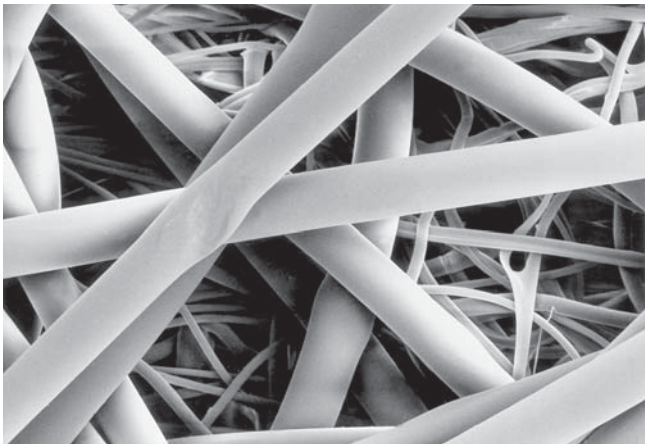
MICROPOROUS FILM (MPF)

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. ▶

1:500 **Source:** DuPont.

SPUNBOUND/MELTBLOWN/SPUNBOUND (SMS)

The performance of SMS fabrics relies on a meltblown polypropylene layer sandwiched between two open 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. ▶



1:500 **Source:** DuPont.

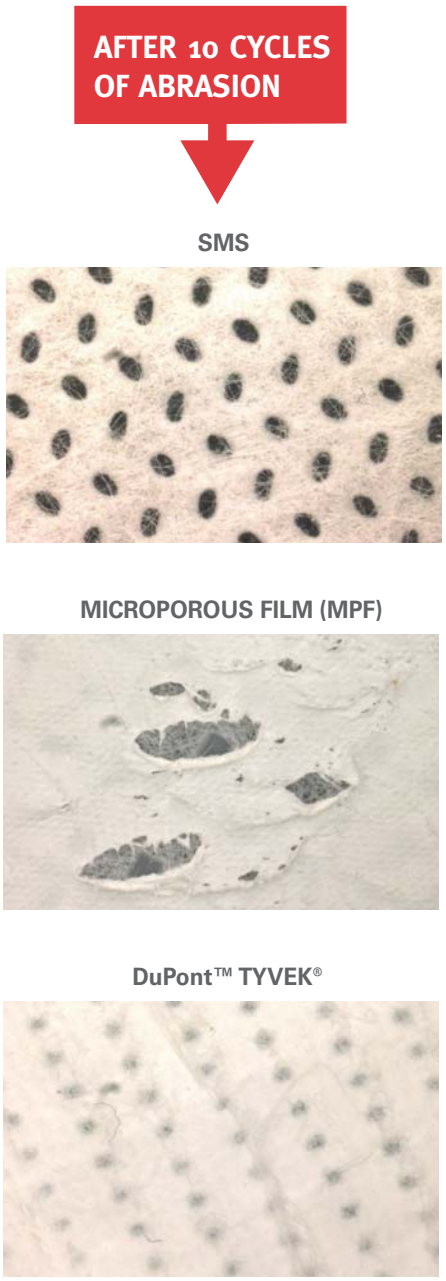
DURABILITY OF SMS, MPF AND TYVEK® FABRICS

The figure illustrates fabric durability after 10 cycles of abrasion. At first glance SMS fabric remains unaffected but it has lower performance level. MPF protection barrier is impacted . The film gets abraded very easily and one can see that there are holes in the film. Only Tyvek® remains unaffected and has the highest protection level. ▶

LINTING

'Linting' refers to the tendency for some types of yarned and stapled fabric fibres to shed tiny particles into the atmosphere. This fibre displacement is greatly exacerbated when the fabrics are being moved or manipulated as is the case when working in a protective garment. In this case the lint that is shed can be a major source of contamination in applications ranging from paint spraying to cleanroom to hygiene-sensitive processes. On the other hand, fabrics manufactured from continuous synthetic filaments, such as Tyvek® have very low linting propensity and are suitable for medical, hygiene, paint and other particle-sensitive applications.

Figure 2. Abrasion: Simulation of wear and tear in everyday use.



Source: DuPont.

ANNEXE 4:
FABRIC TESTING

MANDATORY TESTS

A CE marking signifies that chemical protective clothing meets certain minimum requirements (please see Annexe 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 Annexe 2.

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

Table 7. 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 textile 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 sewn 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 typically only 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 8. Type 6 certified garments – tests.

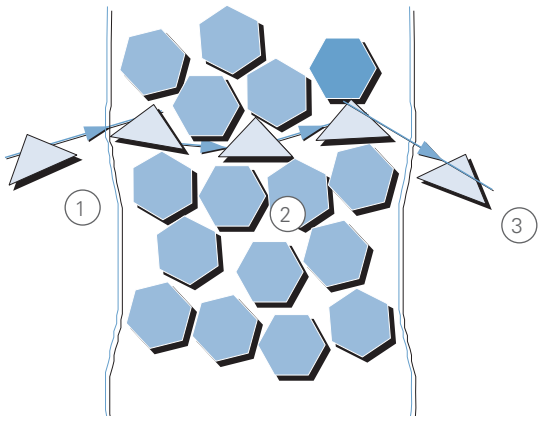
	Test method	Norm	Scope/Principle
Protection	Penetration by liquids	EN ISO 6530	Gutter test method determines indices of penetration, repellency and absorption by applying a fine stream of a test liquid to the surface of a clothing material resting in a inclined gutter.
	Permeation by liquids	EN ISO 6529 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 3. Permeation.

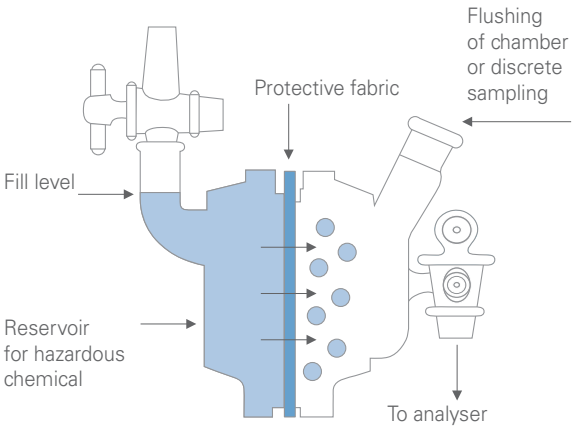


Source: DuPont.

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. ▶

Figure 4. Permeation test cell.



Source: DuPont.

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.

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. ▼

Table 9. 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

* EN 14325: Protective clothing against chemicals – test methods and performance classification of chemical protective clothing

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.

[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.

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'.

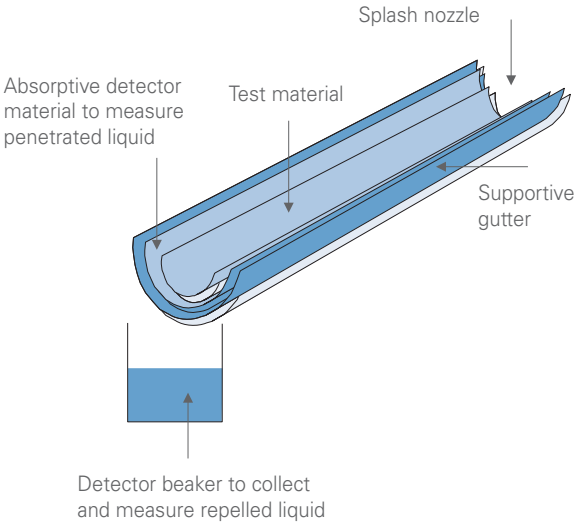
SCHEMATIC OF THE TEST APPARATUS

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.

Figure 5. Gutter Test.



Source: DuPont.

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. ▼

NO CHEMICAL PERMEATION DATA FOR YOUR CHEMICAL?

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

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.

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

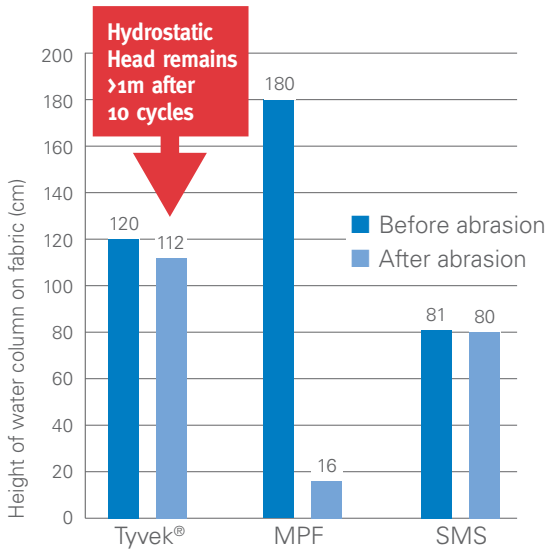
THE EFFECTS OF ABRASION

THE EFFECTS OF ABRASION ON A FABRIC'S RESISTANCE TO PERMEATION AND PENETRATION

Fabric abrasion can seriously undermine the protective efficiency of a fabric. For example, fabrics that rely on thin coatings (please see Annexe 3) or have an inherently weak physical structure can quickly and easily lose their resistance to penetration under operating conditions. This loss of protection is particularly dangerous because in many cases the damage is not readily apparent or is not discovered until after an exposure occurrence. The susceptibility of some fabrics to a severe deterioration in penetration resistance following abrasion can be seen in the following hydrostatic pressure test. Hydrohead is an indicator for liquid barrier performance. It determines the resistance of a fabric to water penetration under slight pressure.

Prior to the abrasion test Microporous Film offers the best resistance to liquid pressure. But after just 10 cycles of abrasion, its performance takes a spectacular dive, while SMS is less affected but starts from a much lower performance level, and Tyvek® continues to protect. After abrasion, Tyvek® penetration performance is the highest. ▶

Figure 6. Liquid barrier performance. Hydrostatic Head: EN 20811. Before and after 10 cycles of abrasion (EN 530 - Method 2).

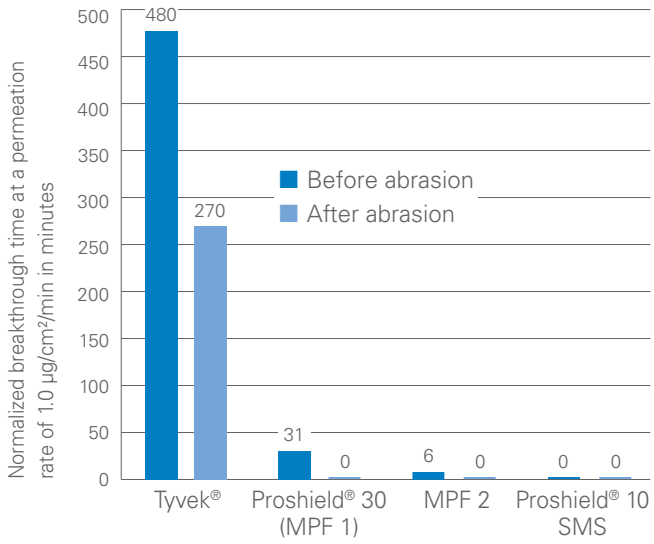


Based on mean value
N=144 specimens tested.
Source: Independent Institute.

THE EFFECTS OF ABRASION ON A FABRIC'S RESISTANCE TO PERMEATION

The illustrations illustrate how the homogenous structure of a fabric such as Tyvek®, where the barrier properties are a function of the inherently tough material itself rather than a thin coating or layer, offer much superior and more reliable permeation resistance under under working conditions and over prolonged wear times compared to similar laminated products. ▶

Figure 7. Permeation resistance to sulfuric acid 18%.



Source: Independent Institute.

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 10. 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 11. Protective clothing Types according to EN 14126:2003.

Type	Description	Relevant standard
1a-B, 1b-B, 1c-B	Gas-tight	EN 943-1:2002, EN 943-2:2002
2-B	Non gas-tight	EN 943-1:2002, EN 943-2:2002
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.

ANNEXE 5:
WHOLE GARMENT PERFORMANCE

'A chain is no stronger than its weakest link' is a principle that 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 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.

TYPE TESTING

In accordance with the EU CE requirements (please see Annexe 1), chemical protective (Category III) clothing is subdivided into six levels or 'Types' of protection (please see Annexe 2) 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 Annexe 3) 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.

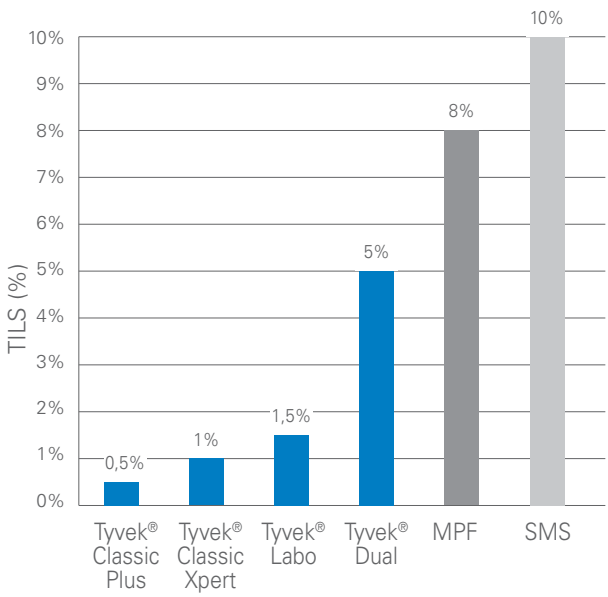
A WORD OF CAUTION

The EN whole-suit Type-tests (please see Annexe 3) 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, penetration spots at a maximum of 3 cm^2 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. ▶

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.



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

Source: Independent Institute.

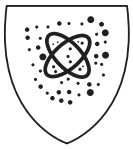
WHOLE-SUIT TYPE TESTS

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

PROTECTION AGAINST RADIOACTIVE PARTICULATES

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.

STANDARD EN 1073



The EN 1073-2 standard was developed for the nuclear industry and relates to the barrier properties of protective suits against contaminated solid particulates. It does not apply to protection from ionising radiation. The EN 1073-2 applies a recognised test method (EN ISO 13982-2) to determine the inward leakage and the barrier efficiency of the garment when challenged under controlled conditions. Three levels of performance class are assigned to garments subjected to this test although the very broad performance spans of these three bands renders them, at best, a very blunt instrument for evaluating the relative performance of different garments.

However the same EN test results can be expressed as a 'Nominal Protection Factor' (NPF) which assigns a specific numeric value to the protection provided. This makes it possible to compare suits within the same Class, for example to compare a suit that is at the very bottom of Class 2 with one at the very top of Class 2.

Class 1: Lowest particle barrier NPF 5 to 49.
Class 2: Intermediate particle barrier NPF 50 to 499.
Class 3: Highest particle barrier NPF >500.

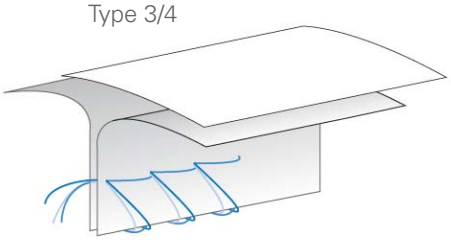
SEAM CONSTRUCTION AND PERFORMANCE

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. ▶

Figure 9. Three types of seam construction.

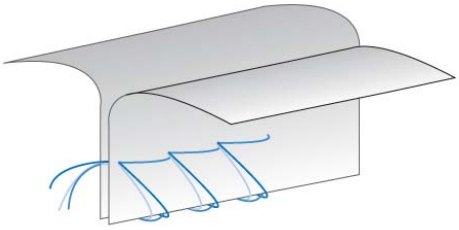
Type 3/4



STITCHED & OVERTAPED SEAMS

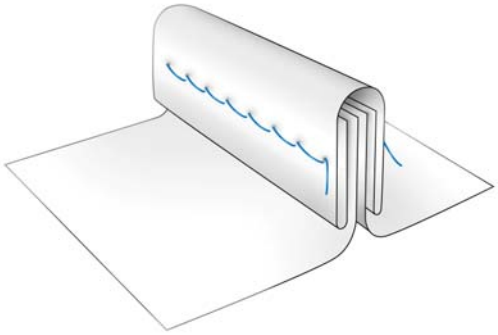
Seams can be stitched and overtaped. The tapes used for DuPont products with this type of seam offer a barrier equal to that of the fabrics.

Type 5/6



STITCHED SEAMS

Stitching offers good balance between seam strength and seam barrier.



BOUND SEAMS

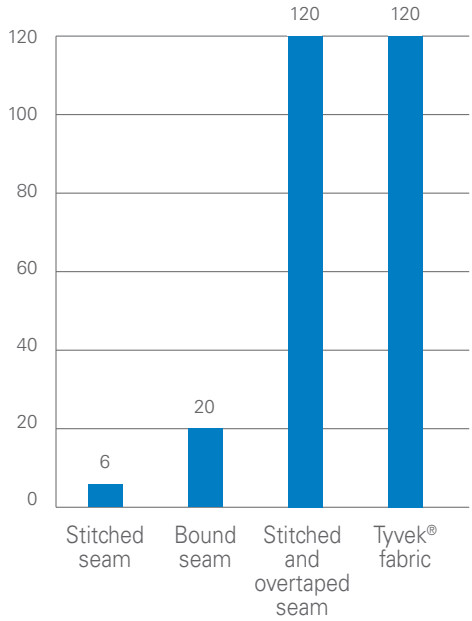
Seam construction leaves the needle holes visible. Construction is unlikely to offer permeation barrier equal to the fabric.

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. ▶

Figure 10. Pressurized exposure resistance. Hydrohead DIN EN 20811 (centimeters of H_2O).

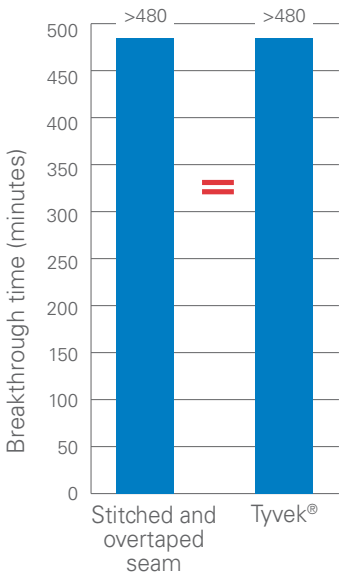


N=16 specimens tested
Source: DuPont.

PERMEATION RESULTS

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

Figure 11. Permeation EN ISO 6529 with Sodium Hydroxide NaOH 40% (BT 1.0 normalized breakthrough time at 1.0 µg/cm²/min.).



N=16 specimens tested
Source: Independent laboratory.

ANNEXE 6:
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.
- ✓ Breatheability: 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.

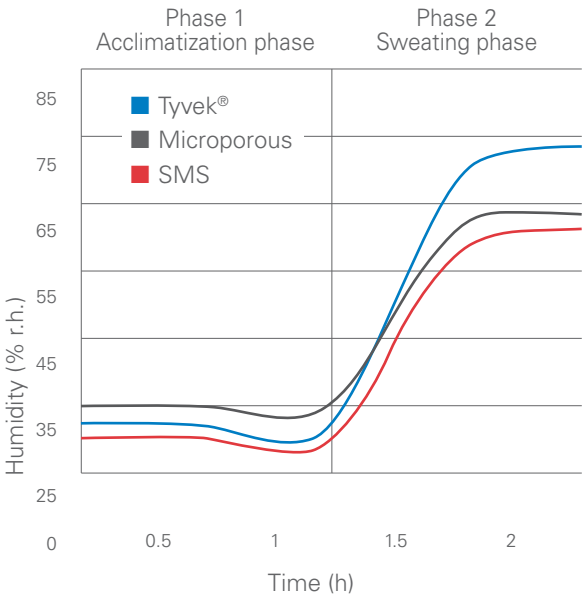
The Tyvek® barrier fabric from DuPont™ uses a proprietary non-woven fabric structure to provide a protective fabric that actually allows moisture vapour to pass through.

The material is formed from High Density Polyethylene (HDPE), with diameters as low as 1/150th 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

Figure 12. Humidity between underwear and garment (by family).



N=5 garments tested
Source: Independent Institute.

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

ANNEXE 7:
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. ▼

Table 12. Categories of Ex-Zones.

Ex protective Zones for gases, vapours and mists	
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 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 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.

Ex protective Zones for dust	
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 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 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

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. ▶

Table 13. Examples of explosion groups.

IIA	IIB	IIC
Acetone Benzene Toulene	Ethylene Ethylene oxide Diethyl ether	Acetylene Hydrogen Carbon disulphide

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

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.

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 'ATEX 95' equipment directive 94/9/EC[2] is for equipment manufacturers and covers equipment and protective systems intended for use in potentially explosive atmosphere.[3]
- ✓ The 'ATEX 137' workplace directive 99/92/EC[4] 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 1149-5:2008[5] 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 94/9/EC on equipment and protective systems intended for use in potentially explosive atmospheres.
[3] A new ATEX Directive 2014/34/EU on the harmonisation of the laws of the Member States relating to equipment and protective systems intended for use in potentially explosive atmospheres will be applicable from 20 April 2016.
[4] Directive 99/92/EC Minimum requirements for improving the safety and health protection of workers potentially atr isk from explosive atmospheres.
[5] EN 1149 - 5:2008 Protective clothing with electrostatic properties.

ANNEXE 8:
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: ▼

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.

ANNEXE 9:
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 operational 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)
Tyvek®	10
Tyvek® 800 J	5
Tychem® C	10
Tychem® F	10
Tychem® F2	10
Tychem® TK	10
Tychem® 4000 S	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.

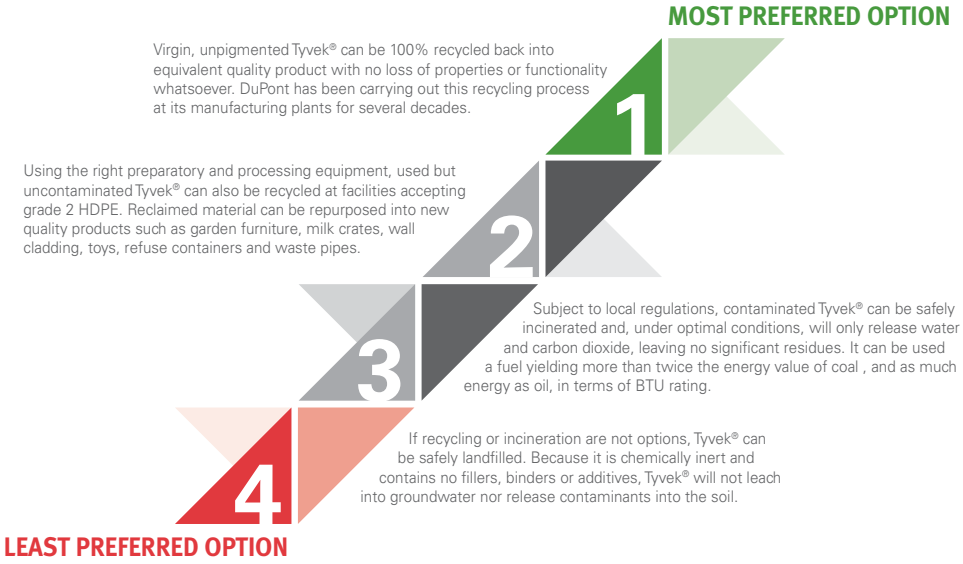
ANNEXE 10:
GARMENT DISPOSAL AND END-OF-LIFE OPTIONS

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 100% High Density Polyethylene (HDPE). It is produced by DuPont de Nemours Luxembourg S.à r.l. Under an environmental policy verified to ISO 140011. 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. ▼

Figure 13. End-of-life options for Tyvek® products.



Source: DuPont.

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.

DISCLAIMER

This information is based upon technical data that DuPont believes to be reliable. It is subject to revision as additional knowledge and experience becomes available. DuPont does not guarantee results and assumes no obligation or liability in connection with this information.

It is the user's responsibility to determine the level of toxicity and the proper personal protective equipment needed. This information is intended for use by persons having the technical expertise to undertake evaluation under their own specific end-use conditions, at their own discretion and risk.

Anyone intending to use this information should first check that the garment selected is suitable for the intended use. The end-user should discontinue use of garment if fabric becomes torn, worn or punctured, to avoid potential chemical exposure. Since conditions of use are beyond our control, we make no warranties, expressed or implied, including but not limited to warranties of merchantability or fitness for a particular purpose and assume no liability in connection with any use of this information.

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