



# Product Catalogue

DuPont Personal Protection

• DUPONT •

**Kevlar.** | **Nomex.** | **Tyvek.** | **Tychem.**





## DuPont Personal Protection CONTENT OVERVIEW

<b>I.</b>	<b>Introduction</b>	
	Innovation that meets your needs	5
	DuPont product range	6
	Garment selection: A life-saving choice	8
	Training, storage and other ongoing considerations	11
	DuPont™ SafeSPEC™ active assistance	11
<b>II.</b>	<b>Tyvek® Garments and accessories</b>	12
<b>III.</b>	<b>Tychem® Garments and accessories</b>	22
<b>IV.</b>	<b>ProShield® Garments</b>	38
<b>V.</b>	<b>Tyvek® Isoclean® Garments and accessories</b>	44
<b>VI.</b>	<b>DuPont™ Kevlar®</b>	52
<b>VII.</b>	<b>DuPont™ Nomex®</b>	64
<b>VIII.</b>	<b>Appendices</b>	
	The 9-step guide from DuPont to garment selection	77
	Recommended donning and doffing	86
	Product part numbers	88





## Innovation that meets your needs

Providing professionals everywhere with the trusted personal protection they need, for the greater good of all.

For decades, DuPont innovations have helped save countless lives. DuPont scientists work tirelessly to invent new materials that are used to develop a large range of Personal Protective Equipment. These include leading brands such as Kevlar®, a world-class material used extensively in life protection ballistic systems; Nomex®, which makes flame and arc protection products possible; Tyvek® and Tychem®, the industry-leaders for chemical protective clothing.

Our latest innovation, the Tychem® chemical glove range has been designed to match protection level provided by Tychem® garments. The gloves offer perfect compatibility with DuPont coveralls to create a Tychem® Trusted Chemical System™.

Today, DuPont is combining all of this expertise and experience under one name, to create a single, powerful division: DuPont Personal Protection. This united division will make it easier for everyday heroes to find the ideal solution for their requirements, and access the right product at the right time, in the right place.

At DuPont, we understand that finding the right kind of protective equipment to meet individual market requirements isn't enough. We listened to what the market needs and realised that we have to go beyond just developing products, and so we created DuPont™ SafeSPEC™, our online tool dedicated to helping our customers find the right protective product for their specific application in chemical protection. The tool addresses every requirement, from full-body coveralls

to protective gloves, and ensures that each product is performance-matched to provide a coherent and comprehensive approach to personal protection.

For customers working in the petrochemical, oil & gas and electrical utility sectors, the Nomex® Knowledge Center, <https://knowledge.nomex.com>, provides advice and product selection support for workers looking for protective clothing for heat, flame and electrical arc hazards.

Our team of experts, based in Luxembourg and Geneva, run regular training sessions for our channel partners and end customers, where we share knowledge, experience and best practices. These sessions help raise awareness of the importance of PPE and how to make the right choices when selecting protective equipment.

Everything we do is focused on one goal, making it easier for everyday heroes around the world to accomplish extraordinary things, For Greater Good™.



DuPont Product Range

Tyvek®

Superior protection against particulates and water-based chemical splashes	Tyvek® 400	Providing an ideal balance of protection, durability and comfort	Cat.III, Type 5-B, 6-B,EN 14126, EN 1073-2, EN 1149-5
	Tyvek® 500 Xpert	Setting a new standard of protection in the Type 5 and 6 category through greater protection and comfort	Cat.III, Type 5-B, 6-B, EN 14126, EN 1073-2, EN 1149-5
	Tyvek® 500 HV	All-in-one solution: high-visibility (to the highest class), chemical, biological and antistatic protection in one coverall	Cat.III, Type 5-B, 6-B, EN 14126, EN 1073-2, EN 1149-5, EN ISO 20471, RIS-3279-TOM Issue 1 (replaces GO/RT 3279 Issue 8)
	Tyvek® 600 Plus	Combining Type 4 performance with the durability, protection and comfort of a Tyvek® garment	Cat.III, Type 4-B, 5-B, 6-B,EN 14126, EN 1073-2, EN 1149-5
	Tyvek® 800 J	The new, breathable Type 3 garment for protection against water-based inorganic chemicals under pressure	Cat.III,Type 3-B, 4-B, 5-B, 6-B, EN 14126, EN 1073-2, EN 1149-5

ProShield®

Limited particulate and liquid protection	ProShield® 20	Based on SMS technology, breathable lightweight coverall for entry-level Type 5, 6 protection	Cat.III, Type 5, 6 EN 1073-2, EN 1149-5
Flame retardant, limited particulates and liquid protection	ProShield® 20 SFR	The solution to protect you and your flame-resistant workwear underneath	Cat.III, Type 5, 6, EN 1073-2, EN 1149-5, EN ISO 14116
Limited particulate and liquid protection	ProShield® 60	Best in class microporous film at a highly economical price	Cat.III, Type 5, 6 EN 1073-2, EN 1149-5

DuPont Product Range

Tychem®

Concentrated inorganic chemicals	Tychem® 2000	Comfortable, lightweight protection against biohazards and inorganic chemicals	Cat.III, Type 3-B, 4-B, 5-B, 6-B, EN 14126, EN 1073-2, EN 1149-5
Concentrated inorganic chemicals	Tychem® 2000 C Plus	Comfortable, lightweight protection against biohazards and inorganic chemicals	Cat.III, Type 3-B, 4-B, 5-B, 6-B, EN 14126, EN 1073-2, EN 1149-5
Chemical and secondary flame protection	Tychem® 2000 SFR	A new generation of secondary flame-resist-ant chemical chemical garment technology.	
Supple protection against a broad range of inorganic and organic chemicals	Tychem® 4000 S	A new comfortable alternative against a broad range of inorganic and organic chemicals	Cat.III, Type 3-B, 4-B, 5-B, 6-B, EN 14126, EN 1073-2, EN 1149-5
Barrier technology combined with cutting edge features	Tychem® 6000 F	Tychem® 6000 F barrier in new innovative design	Cat.III, Type 3-B, 4-B, 5-B, 6-B, EN 14126, EN 1073-2, EN 1149-5
High levels of protection, compatibility with respiratory equipment	Tychem® 6000 F FaceSeal	Tight design combined with trusted Tychem® protection	Cat.III, Type 3-B, 4-B, 5-B, 6-B EN 14126, EN 1073-2, EN 1149-5
Combined chemical, heat&flame and electric arc protection	Tychem® 6000 FR ThermoPro	Single layer, triple-threat protection (chemical, heat & flame, electric arc) for 360° protection	Cat.III, Type 3-B, 4-B, 6-B EN 14126, EN 1149-5, EN ISO 11612, EN ISO 14116, IEC 61482-2, EN ISO 11611
Gaseous substances	Tychem® 10000 TK	Exceptional protection against a broad range of toxic, corrosive gases, liquids and chemicals	Cat.III, Type 1a-ET

Garment selection: a life saving choice

There are many different chemical protective suits commercially available, and although they are CE certified, there are very wide ranging performance differences for products meeting the same certification 'Types'. Faced with a bewildering choice and the complexity of the certification information, what criteria should be used to select the right protective clothing? A short summary of the European standards for chemical protective clothing and a chemical protective clothing selection guide is provided to assist you in this task.

CE 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'.

Garment selection: a life saving choice



Chemical Protective Clothing, Category III

Pictogram*	Type	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 943-1:2019** EN 943-2:2019
	TYPE 2	Non-Gas-Tight Protective clothing against liquid and gaseous chemicals, including liquid aerosols and solid particles.	EN 943-1:2019**
	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 1149-5:2018
	Protective clothing against radioactive contamination.	EN 1073-2 :2002
	Protective clothing with protection against heat and flame-Limited flame spread materials, material assemblies and clothing.  Three 'Index' (levels) of protection are defined Index 1 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
	High-visibility clothing - Test methods and requirements.	EN ISO 20471:2013

More detailed garment selection information can be found in Appendices.

\* 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.





## 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 **NEW!**

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

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



[www.safespec.dupont.asia](http://www.safespec.dupont.asia)







# Tyvek®




# Tyvek® 400




Category III




TYPE 5



TYPE 6



EN 1149-5




EN 1073-2\*  
Class 2

Providing an ideal balance of protection, durability and comfort.




Tyvek® offers an excellent barrier against fine particles and fibres (down to 1 micron in size), is ultra-low-linting, antistatically treated.


Stitched external seams for enhanced protection against penetration from the outside to the inside of the garment.




Oil and gas




Maintenance operations




Paint spraying



Pharmaceutical industry



Work Involving composite materials



Waste Handling




3 piece hood

DuPont Code: Size	D13674427: SM D13674430: MD D13674444: LG D13674455: XL D13674461: 2X D13674479: 3X Carton Qty – 100EA
-------------------	--




\* Does not protect from ionizing radiation.


# Tyvek® 400 Dual




Category III




TYPE 5



TYPE 6



EN 1149-5



EN 1073-2\*  
Class 1

Protection and durability in the front breathability in the back.



Tyvek® protection where you need it most.

Large breathable SMS back panel from head to ankle for increased comfort.

External stitched seams for enhanced protection against penetration from the outside to the inside of the garment.



Frontal exposure during firing, foundries and smelting operations



Paint spraying



Work involving composite materials



Maintenance operations



3 piece hood



SMS back panel



Elasticated waist

DuPont Code: Size	D14809606:SM D14809610: MD D14809622: LG D14809637: XL D14809645: 2X D14809658: 3X Carton Qty - 100EA
-------------------	---



\* Does not protect from ionizing radiation.









# Tyvek® 500 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.



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

-   
Oil and gas
-   
Maintenance operations
-   
Paint spraying
-   
Pharmaceutical industry
-   
Work Involving composite materials
-   
Waste Handling



Good hood fit



Long zipper puller



Ergonomic shape








**DuPont Code: Size White**  
D14663953: SM  
D14663967: MD  
D14663977: LG  
D14663986: XL  
D14663997: 2X  
D14664003: 3X  
Carton Qty - 100EA

**DuPont Code: Size Orange**  
D13814044: SM  
D13675136: MD  
D13675140: LG  
D13675152: XL  
D13675167: 2X  
D13675175: 3X  
Carton Qty - 50EA



\* Does not protect from ionizing radiation.

# Tyvek® 500 HV

-   
Category III
-   
EN ISO 20471  
RIS-3279-TOM-1\*
-   
TYPE 5-B
-   
TYPE 6-B
-   
EN 1149-5
-   
EN 1073-2\*\*  
Class 1
-   
EN 14126

High visibility that doesn't wash out!



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

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



Collar



Fluorescent orange for day visibility



Retro-reflective bands for night visibility

**DuPont Code: Size**  
D14663953: SM  
D14663967: MD  
D14663977: LG  
D14663986: XL  
D14663997: 2X  
D14664003: 3X  
Carton Qty - 100EA



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

# Tyvek® 600 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.



On this picture, the user wears **Tychem® NT470 Gloves**.

Combines performance of a Type 4 with the comfort of a nonwoven suit.

Stitched and overtaped seams, offering equal barrier as fabric.

Hood shape and elastic around hood are designed for a tight fit around full face respirator.

Tunnelled elastics, cuff, ankles and face help to reduce the risk of contamination.



**Nuclear industry**



**Medical applications**



**Biological hazards**



Elasticated waist



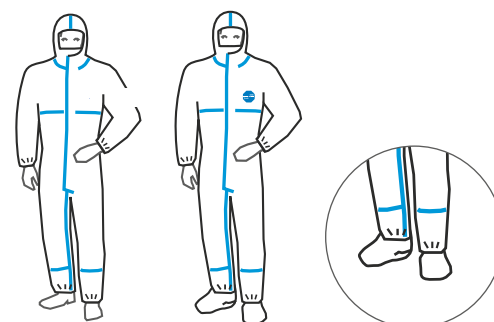
Thumb loops



Also available with socks

## DuPont Code: Size

D14981410: XS	D13495752: 3X
D13495782: SM	D14981422: 4X
D13395307: MD	D14981437: 5X
D13395299: LG	D14981445: 6X
D13395284: XL	D14981458: 7X
D13395272: 2X	
Carton Qty – 100EA	



\* Does not protect from ionizing radiation. \*\* Not applicable to green model. MTO = Made to order.

Tyvek®

# 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.



An effective barrier against many low-concentration, water-based inorganic chemicals (even under pressure), small-sized hazardous particles as well as oil repellent.

Bright, over-taped seams aid wearer identification.

Soft and lightweight fabric that is permeable to both air and water vapour.

Ergonomic fit consistent with the shape and movement of the user.



**Liquid protection and/or oil repellency**



**Petrochemical installations**



**Maintenance operations**



**Waste handling**



**Chemical processing**



Self-adhesive chin flap



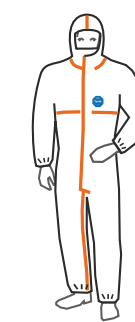
Elasticated waist



Thumb loops

## DuPont Code: Size

D15441654: SM	D15441708: 3X
D15441661: MD	D15441717: 4X
D15441676: LG	D15441728: 5X
D15441684: XL	D15441735: 6X
D15441698: 2X	D15441740: 7X
Carton Qty – 25EA	








\* Does not protect against ionizing radiation.

Tyvek®







Tyvek® 400 Accessories

Specially designed for use with Tyvek® apparel, Tyvek® 400 accessories can help offer enhanced protection for body parts that are more exposed to hazardous substances, or protect processes from contamination.

	<p><b>Tyvek® 400 Labcoat with press studs and pockets</b> Labcoat with collar, available in white and in sizes MD to 2XL. 5 press stud closures. 3 pockets. Stitched internal seams. <b>CE Category &amp; Type:</b> Cat. III - Type PB[6]*</p>	Carton Qty - 50EA
	<p><b>Tyvek® 400 Apron</b> Shin-length apron with neck and waist ties. Available in white and in one size (length 108 cm). <b>CE Category &amp; Type:</b> Cat. III - Type PB[6]*</p>	Carton Qty - 100EA
	<p><b>Tyvek® 400 Jacket</b> Hooded jacket available in white and in sizes MD to 2XL. Zipper closure. Stitched internal seams. <b>CE Category &amp; Type:</b> Cat. III - Type PB[6]*</p>	Carton Qty - 50EA
	<p><b>Tyvek® 400 Trousers</b> Trousers available in white and in sizes MD to 2XL. Without pockets. Elasticated waist, no elastic at ankles. Stitched internal seams. <b>CE Category &amp; Type:</b> Cat. III - Type PB[6]*</p>	Carton Qty - 50EA
	<p><b>Tyvek® 400 Hood</b> Hood with flange and elasticated face and neck. Available in white and in one size. <b>CE Category &amp; Type:</b> Cat. III - Type PB[6]*</p>	Carton Qty - 100EA

Tyvek® 400 Accessories

	<p><b>Tyvek® 400 Sleeve</b> 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. <b>CE Category &amp; Type:</b> Cat. III - Type PB[6]*</p>	Carton Qty - 200EA
	<p><b>Tyvek® 400 Boot cover</b> Knee-length overboot available in white and in one size. Elasticated top and fixation ties. Stitched internal seams. <b>CE Category &amp; Type:</b> Cat. III - Type PB[6]*</p>	Carton Qty - 200EA Made to Order
	<p><b>Tyvek® 400 Boot cover with antislip</b> Knee-length overboot available in white and in one size. Elasticated top and fixation ties. Stitched internal seams. Slip-retardant sole. <b>CE Category &amp; Type:</b> Cat. III - Type PB[6]*</p>	Carton Qty - 200EA
	<p><b>Tyvek® 400 Shoe cover</b> Shoe cover available in white and in one size (38 cm long). Elasticated ankle. Stitched internal seams. <b>CE Category &amp; Type:</b> Cat. III - Type PB[6]*</p>	Carton Qty - 400EA
	<p><b>Tyvek® 400 Shoe cover with antislip</b> Shoe cover available in white and in sizes 36 to 42 and 42 to 46. Elasticated ankle. Stitched internal seams. Slip-retardant sole. <b>CE Category &amp; Type:</b> Cat. III - Type PB[6]*</p>	Carton Qty - 200EA











# Tychem®

Garments & Accessories





Tychem® 2000

- 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 numerous inorganic chemicals.



Protection against numerous concentrated inorganic chemicals and biohazards.

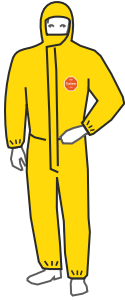
Protective seams, stitched and over-taped with barrier-tape, providing barrier performance equal to that of the fabric.

Double self-adhesive zipper flap offers high level of protection.

- Food processing
- Emergency response
- Chemical processing
- Oil and gas
- Healthcare
- Biological hazards











Self-adhesive zipper and chin flap



**DuPont Code: Size**

D13675305: SM  
D13675315: MD  
D13675324: LG  
D13675336: XL  
D13675340: 2X  
D13675352: 3X  
Carton Qty – 50EA

Tychem® 2000 C Plus

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





Tychem® 2000 C barrier in new innovative design.



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 zipper system with self-adhesive zipper flap and double cuffs offers an additional level of protection.

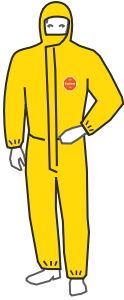
- Food processing
- Emergency response
- Chemical processing
- Oil and gas
- Healthcare
- Biological hazards



Double zipper system



Thumb loops and double cuff



**DuPont Code: Size**

D15334564: SM  
D15334570: MD  
D15334587: LG  
D15334591: XL  
D15334603: 2X  
D15334618: 3X  
Carton Qty – 20EA

\* Does not protect against ionizing radiation.

\* Does not protect against ionizing radiation.

Tychem® 2000 C Accessories

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



**Tychem® 2000 C Gown**

Shin-length gown with wrap-over rear closure, hook and loop neck closure and waist ties. Elasticated wrists.

**Color & Size:** Available in yellow and sizes SM/MD and LG/2XL

**CE Category & Type:** Cat. III - Type PB[3]\*

Carton Qty: 25EA



**Tychem® 2000 C Apron**

Shin-length apron with neck and waist ties.

**Color & Size:** Available in yellow and in one size

**CE Category & Type:** Cat. III - Type PB[3]\*

Carton Qty - 25EA



**Tychem® 2000 C Sleeve**

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

**Color & Size:** Available in yellow and in one size

**CE Category & Type:** Cat. III - Type PB[3]\*

Carton Qty - 50EA



**Tychem® 2000 C Boot cover**

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

**Color & Size:** Available in yellow and in one size

**CE Category & Type:** Cat. III - Type PB[3]\*


Carton Qty - 50EA


Tychem® 2000 SFR


Provide chemical and secondary flame protection in a lightweight garment.





Tychem® 2000 SFR garments are intended to be worn over primary flame resistant garments. In the event that a flash fire occurs, they won't ignite and won't contribute to additional burn injury if appropriate flame-resistant personal protective equipment, such as DuPont™ Nomex®, is worn beneath.


- 

Food processing
- 

Emergency response
- 

Chemical processing
- 

Oil and gas
- 

Healthcare
- 

Biological hazards

**Warning:** Tychem® 2000 SFR garments provide secondary flame resistance; **they must be worn over appropriate primary flame-resistant garments** (such as Nomex® Soft-**See page 64 for more information**). Tychem® 2000 SFR garments should not be worn alone in areas where flame exposure may occur.

DuPont Code: Size	D15526968:SM D15526969:MD D15526970:LG D15526971:XL D15526972:2X D15526973:3X D15526974:4X D15526975:5X D15526976:6X D15526977:7X Carton Qty – 4EA
-------------------	--



\* 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.**



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.



Oil and gas



Emergency  
response



Chemical industry



Double zip  
closure



Double cuff  
system



**DuPont Code: Size**

D15193449: SM  
D15193451: MD  
D15193467: LG  
D15193473: XL  
D15193481: 2X  
D15193494: 3X  
Carton Qty – 20EA

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



Tychem® 6000 F



Tychem® 6000 F barrier in new innovative design.



Protection against numerous toxic industrial organic chemicals, highly concentrated inorganic chemicals and biohazards. Chemical permeation data available for more than 250 chemicals.

Protective seams, stitched and over-taped with barrier-tape, providing barrier performance equal to that of the fabric.

Double zipper system with self-adhesive zipper flap offers high level of protection.



Self-adhesive chin and zipper flap

<b>DuPont Code: Size</b>	D13675215: SM D13675224: MD D13675236: LG D13675240: XL D13675252: 2X D13675267: 3X Carton Qty – 25EA
--------------------------	---



\* Does not protect against ionizing radiation.

Tychem® 6000 F Plus



Tychem® 6000 F Plus barrier in new innovative design.



Protection against numerous toxic industrial organic chemicals, highly concentrated inorganic chemicals and biohazards. Chemical permeation data available for more than 250 chemicals.

Protective seams, stitched and over-taped with barrier-tape, providing barrier performance equal to that of the fabric.

Double zipper system with self-adhesive zipper flap offers high level of protection.



Double zipper system



Self-adhesive chin and zipper flap



Thumb loops

<b>DuPont Code: Size</b>	D15344168: SM D15344179: MD D15344186: LG D15344191: XL D15344201: 2X D15344210: 3X Carton Qty – 10EA
--------------------------	---



\* Does not protect against ionizing radiation.



Tychem® 6000 F FaceSeal



Tight design combined with trusted Tychem® protection.



Tight design technologies: rubber seal around the mask offers good compatibility with full face mask and sealed in gloves for full body protection.

No need for taping, enables faster donning in emergency situations and industrial applications.

Rear entry with double flaps for enhanced safety of the wearer from frontal exposure.

Attached dissipative socks with boot flap.

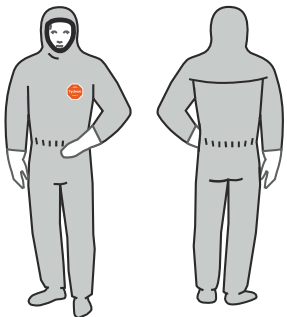
Enables earthing of the wearer through dissipative shoes without need for additional earthing cables.

Specially for emergency responder teams who may stock the garments for longer periods of time, the manufacturing date is featured on the box packaging.



Tight fitting hood      Double zipper flap      Attached under gloves

DuPont Code: Size	D15490341: SM D15490481: MD D15490467: LG D15490543: XL D15490598: 2X D15490650: 3X D15490706 : 4X D15490762 : 5X Carton Qty – 1EA
-------------------	--



Tychem® 6000 F Accessories

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

**Tychem® 6000 F Gown**

Shin-length gown with wrap-over rear closure, hook and loop neck closure and waist ties. Elasticated wrists.

**Color & Size:** Available in grey and sizes SM/MD and LG/2XL

**CE Category & Type:** Cat. III - Type PB[3]\*

Carton Qty - 25EA

**Tychem® 6000 F Apron**

Shin-length apron with neck and waist ties.

**Color & Size:** Available in grey and in one size

**CE Category & Type:** Cat. III - Type PB[3]\*

Carton Qty - 25EA

**Tychem® 6000 F Sleeve**

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

**Color & Size:** Available in grey and in one size

**CE Category & Type:** Cat. III - Type PB[3]\*

Carton Qty - 50EA

**Tychem® 6000 F Boot cover**

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

**Color & Size:** Available in grey and in one size

**CE Category & Type:** Cat. III - Type PB[3]\*

Carton Qty - 50EA

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

\* Partial body protection.

# Tychem® 6000 FR ThermoPro



Single layer, triple-threat (chemical, thermal and electric arc) protection garments and accessories for 360° protection.



Synergy of two unique and long-proven technologies from DuPont: **Tychem®** for the chemical protection and **Nomex®** for the heat and flame and electric arc protection.

Protection against organic and inorganic chemicals. Tested for permeation against > 240 chemicals.

Tested on DuPont™ Thermo-Man® thermal mannequin: up to 8% predicted body burn injury for an average of 98% chances of survival in case of a flash fire.

Electric arc rating: ATPV = 15 cal/cm².

Single layer allowing a great scope of movement.

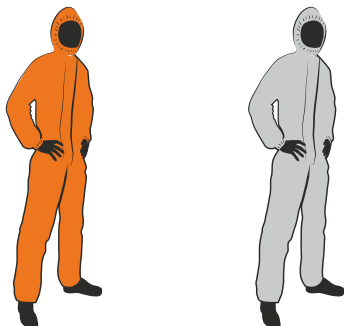
Can be reused if not contaminated or damaged.

Available also as combo solution: Bib-overall and jacket combination.

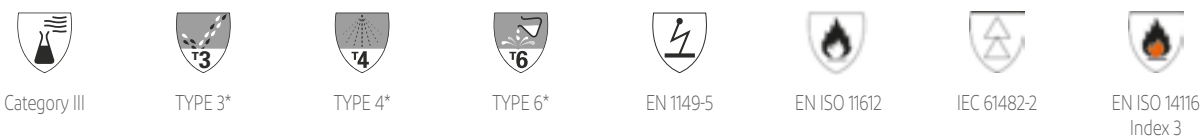


Hood with tight fit to face mask    Flame retardant draw strings    Sleeve cuff with tunneled elastic

DuPont Code: Size	D15490341: SM D15490481: MD D15490467: LG D15490543: XL D15490598: 2X D15490650: 3X D15490706: 4X D15490762: 5X Carton Qty – 1EA
-------------------	--



# Tychem® 6000 FR ThermoPro Combo & Apron



AVAILABLE ALSO AS Combo solution: Two-piece bib overall and jacket combination OR a Sleeved Apron.



## Combo solution: Bib-overall and jacket combination

Collared jacket and bib overall combination available in bright orange for high visibility. Jacket with elasticated wrists and waist. Overall with adjustable webbing straps with buckle closure, open ankles. Jacket comes with double storm flap.



Adjustable straps with buckle closure



Zipper and protective flap



Sleeve cuff with tunneled elastic



## Sleeved Apron

Sleeved gown available in bright orange for high visibility. Adjustable FR buckles at back of waist and shoulder. Integral sleeves with elasticated wrists. Sewn with DuPont™ Nomex® thread Tychem® 6000 FR ThermoPro accessories provide partial body protection (Cat. III PB[3]) and must be used in conjunction with primary flame resistance clothing that is rated for the fire/arc hazard. Typical applications include use in academic and professional laboratories.



Provides frontal protection

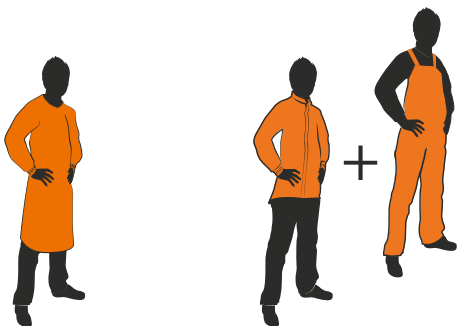


Elasticated wrists



Two buckle closure system

Reference:	TP 0750 T OR CE (Combo solution) TP 0275 T OR CE (Sleeved Apron)
Colour:	Bright orange
Size:	SM to 4XL (Combo solution) SM to 3XL (Sleeved Apron) (All sizes are MTO)



MTO = Made to order. \* Tychem® ThermoPro TP275T Sleeved gown provides partial body protection (Cat. III PB[3]) and does not comply with the requirements of Type 4 and Type 6.



# Tychem® 10000 TK



Category III



TYPE 1a-ET

Effective barrier against more than 300 chemicals for your peace of mind.



Specifically developed to protect against toxic and corrosive gases, liquids and solid chemicals.

Fabric, visor, inner layer glove and seams meet required resistance to permeation for chemicals listed in EN 943-2.

Out of the 300 chemicals tested, no observable break-through in tests for 270 chemicals after 8 hours of exposure.

Puncture- and tear-resistant.

Tychem® 10000 TK Garments available in: Cat III Type 1a, NFPA 1994 Class 2, Fully encapsulated Level A, Full encapsulated Level B and coverall.



Oil and gas



Emergency response



Chemical industry



Model 615T  
Back entry



Attached gloves



Gas-tight  
zip closure

## Reference:

Cat III Type 1a-ET: TK614 (Front Entry)  
Cat III Type 1a-ET: TK615 (Rear Entry)  
NFPA 1994 Class 2: TK612 (Front Entry)  
NFPA 1994 Class 2: TK613 (Rear Entry)  
Level A: TK554 (Front Entry)  
Level A: TK555 (Front Entry)  
Level B: TK527 (Front Entry)  
Coverall: TK128

## Colour:

Lime yellow

## Size:

SM to 6XL (All sizes are MTO)



Tychem®





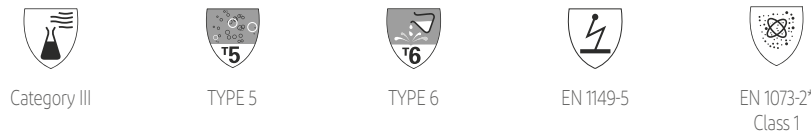
# ProShield®

Garments





ProShield® 20



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

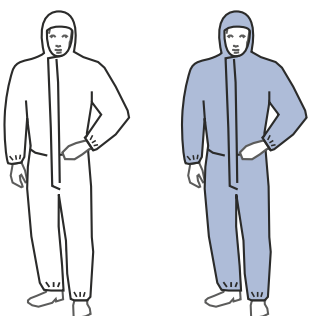


Limited particle protection.  
High comfort level: high air and water vapour permeability.  
Available in blue and white.



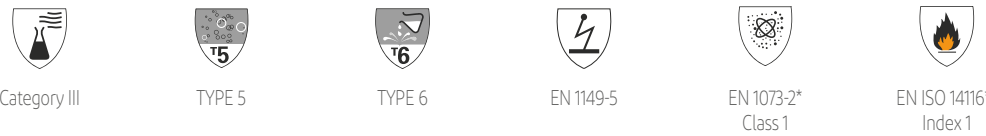
Elasticated hood      Elasticated wrists      Elasticated waist

DuPont Code: Size White	DuPont Code: Size Blue
D15338118: SM	D15338174: SM
D15338122: MD	D15338185: MD
D15338134: LG	D15338191: LG
D15338149: XL	D15338209: XL
D15338157: 2X	D15338211: 2X
D15338160: 3X	D15338227: 3X
Carton Qty - 50EA	Carton Qty - 50EA



\* Does not protect from ionizing radiation.

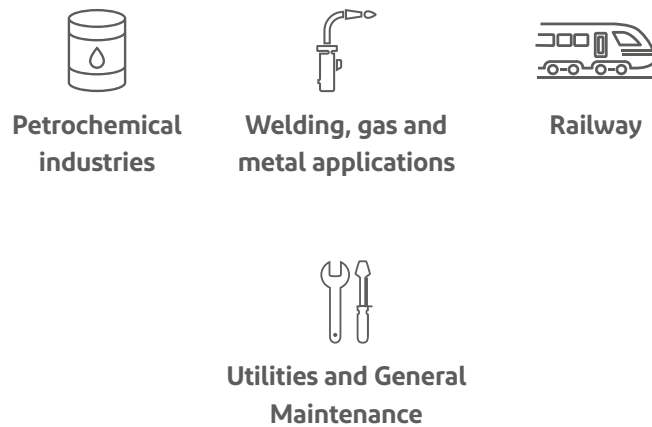
ProShield® 20 SFR



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



Secondary FR coverall designed to protect your Primary FR garment.  
Maximising wearer comfort: thanks to the open structure of its breathable non-woven SMS fabric.  
Non-halogenated flame-retardant non-woven fabric, free of substances of very high concern to be compliant with REACH regulations.  
Antistatic treatment on both sides\*\*.



3 piece hood      Elasticated wrists      Elasticated waist

DuPont Code: Size	D14591556: MD D14591547: LG D14591537: XL D14591523: 2X D14591515: 3X Carton Qty - 50EA
-------------------	--



\*\* EN ISO 14116:2008 requires a tensile strength of >150 N. This garment has a tensile strength of >30 N only.  
\*\*\* Test conducted on certain FR fabrics and FR garments have demonstrated that antistatic properties reduce overtime. In the interests of safety, that's why we initially limit the shelf-life for the antistatic property of ProShield® 20 SFR to 18 months.

ProShield® 60



Category III



TYPE 5



TYPE 6



EN 1149-5



EN 1073-2\*  
Class 1

Best in class microporous film at a highly economical price.



New pattern for a better fit.

Good liquid repellency.

Protection against low-medium concentrated water-based chemicals.



General  
maintenance



Industry



Storm flap

Elasticated hood,  
waist, wrists  
and ankles

3-piece crotch  
area

DuPont Code: Size

D15519552: SM  
D15519553: MD  
D15519554: LG  
D15519555: XL  
D15519556: 2X  
D15519557: 3X  
Carton Qty - 50EA



\* Does not protect from ionizing radiation.



# Tyvek® IsoClean®

Garments & Accessories



DuPont Controlled Environments

DuPont sterile cleanroom garments, designed for single use, offer meaningful advantages in today’s challenging cleanroom environments. DuPont materials provide a welcome range of comfort, durability, breathability and protection in a variety of styles, including coveralls, lab coats, gowns, hoods and footwear covers.

DuPont quality systems for cleanroom garments

DuPont single-use garments for controlled environments offer the following standards of quality:

- The DuPont Controlled Environments quality management system is ISO 9001:2015 registered
- DuPont™ Tyvek® IsoClean® sterile garments have a sterility assurance level of 10<sup>-6</sup>. Irradiation doses are validated in accordance with ANSI/AAMI/ISO 11137 through bioburden and dose verification testing
- Tyvek® IsoClean® sterile garments are gamma irradiated in a facility that is registered by ISO 13485 quality standard and adheres to the requirements of ANSI/AAMI/ISO 11137
- A Certificate of Sterility and a Certificate of Compliance come with every shipment of sterile Tyvek® IsoClean® single-use garments
- Dose audits are conducted quarterly to maintain dose validation
- Customers are invited to audit our manufacturing and sterilization facilities
- Quality documentation is readily available on request to help meet customer requirements
- Lot traceability is maintained through garment manufacturing, processing and sterilization

The superiority of single-use garments from DuPont

DuPont single-use garments offer the following advantages:

Quality

Single-use garments are not subjected to multiple cycles of wearing, laundering and sterilization, so fabric barrier and strength are consistent and predictable. Also, DuPont Controlled Environments garments help minimize cross-contamination risk because clean-processing and packaging are done in a facility that only handles new garments.

Flexibility

The DuPont single-use apparel program allows you to order only the quantities that you plan to use, which offers flexibility as your needs change.

Cost control

Single-use garments help eliminate budget uncertainties associated with garment repair, damage and loss, helping you to better predict expenditures.



Among the most popular products in the DuPont Controlled Environments portfolio, Tyvek® IsoClean® clean-processed and sterile single-use garments offer an ideal balance of protection, durability and comfort. In addition, they feature the lowest linting and particle shedding of any garments in the DuPont portfolio.

Options

- CS** Clean and sterile: clean-processed, individually packaged and sterilized by gamma irradiation
- OS** Sterile: individually packaged and sterilized by gamma irradiation
- OC** Clean: clean-processed, individually packaged
- OO or OB** Bulk packaged
- PI** Individually packaged in an opaque bag
- BB** Bulk packaged
- BH** 50/bag
- MP** Multipack

Controlled environments apparel selection guide

DuPont Controlled Environments garments: Tyvek® IsoClean®, Tyvek® Micro-Clean® 2-1-2, ProClean® 6

	Tyvek® IsoClean®				Tyvek® Micro-Clean® 2-1-2		ProClean® 6*	Considerations
	Clean-processed sterile	Sterile	Clean-processed non-sterile	Bulk non-sterile	Sterile	Non-sterile**	Non-sterile	
Environments								
ISO Class 5 Aseptic Cleanrooms (Former FED-STD-209E; Class 100)	✓+	✓			✓			Tyvek® IsoClean® sterile garments offer excellent cleanliness, barrier and sterility assurance level.
ISO Class 6, 7 and 8 Bioburden Control Areas (Former FED-STD-209E; Class 1000, 10,000 and 100,000)	✓+	✓+			✓			Tyvek® IsoClean® sterile garments offer excellent cleanliness, barrier and sterility assurance level.
ISO Class 6, 7 and 8 Cleanrooms (Former FED-STD-209E; Class 1000, 10,000 and 100,000)			✓+	✓+		✓	✓	Tyvek® is durable, low-linting and provides an inherent particle barrier. Clean processing and bound seams should be considered for more critical environments.
Hazards								
Non-hazardous dry particles	✓+	✓+	✓+	✓+	✓+	✓+	✓+	Tyvek® provides an inherent barrier against small particles. Bound seam garments offer a higher level of protection than serged seam garments.
Non-hazardous, light liquid splash	✓	✓	✓	✓			✓+	ProClean® provides an effective barrier against a variety of common non-hazardous liquids.
Hazardous powders Notice: DuPont Controlled Environments garments should not be used in potentially explosive or flammable environments.	✓+	✓+	✓+	✓+				Use bound seam garments when working with hazardous powders.
Hazardous liquid splash Examples: organic solvents, caustics								Please refer to our Tychem® product line for liquid and vapor chemical protection.
Electric arc, industrial fire hazard, welding								Please refer to Nomex® for flame-resistant apparel. Controlled environment garments are not suitable for firefighting activities, nor for protection from hot liquids, steam, molten metals, welding, electric arc or thermal radiation.
Do Not Use								

Comparison within the DuPont portfolio:

✓+ Best

✓ Better

(Blank) Not recommended

\* Barrier properties may be compromised through use.

\*\* Packaged individually.

Do Not Use



# DuPont Controlled Environments

## Tyvek® IsoClean®

Made from Tyvek® brand flashspun polyolefin protective material.

Unique, patented flash-spinning process creates a barrier to dry particles, microorganisms and non-hazardous liquids.

Comfortable, lightweight and durable.

Garments available gamma sterilized to an SAL of 10<sup>-6</sup>.

Serged or bound seams with covered elastic options.

Bound seam garments offer highest particle barrier within DuPont CE product portfolio.

Traceability on all sterilized apparel.

Gripper™ soles offer a higher level of slip resistance than standard PVC soles.

Tyvek® IsoClean® is white.



### Coverall

Bound seams. Bound neck. Dolman sleeve. Zipper closure. Elastic wrists. Elastic ankles.

IC253BWHXX00250B SM-5X  
IC253BWHXX00250S SM-5X  
IC253BWHXX00250C SM-5X  
IC253BWHXX0025CS SM-7X  
Carton Qty - 25EA



### Coverall

Serged seams. Standard hood. Elastic hood opening. Set sleeve. Zipper closure. Elastic wrists. Elastic ankles. Attached thumb loops. Attached boots with PVC soles.

IC105SWHXX002500 MD-3X  
IC105SWHXX00250C MD-3X  
IC105SWHXX0025CS MD-4X  
Carton Qty - 25EA



### Coverall

Bound seams. Bound neck. Dolman sleeve. Zipper closure. Snaps for aseptic donning. Elastic wrists. Elastic ankles.

IC254BWHXX0025CS SM-4X  
Carton Qty - 25EA



### Coverall

Serged seams. Standard collar. Set sleeve. Zipper closure. Elastic wrists. Elastic ankles.

IC181SWHXX002500 SM-8X  
IC181SWHXX00250C SM-4X  
Carton Qty - 25EA

# DuPont Controlled Environments



### Boot cover

Serged seams. Elastic openings. Elastic ankles. Gripper™ sole. 18" high.

IC447SWHXX01000B SM-XL  
IC447SWHXX01000C MD-XL  
IC447SWHXX0100CS MD-2X  
Carton Qty - 100EA (50 pairs)



### Boot cover

Bound seams. Elastic openings. Ties at ankles. Gripper™ sole. 18" high.

IC458BWHXX01000B MD-XL  
IC458BWHXX01000C MD-XL  
IC458BWHXX0100CS SM-XL  
Carton Qty - 100EA (50 pairs)



### Boot cover

Serged seams. Elastic openings. Ties at ankles. PVC sole. 18" high

IC457SWHXX01000B SM-XL  
IC457SWHXX01000S SM-XL  
Carton Qty - 100EA (50 pairs)



### Shoe cover

Serged seams. Elastic openings. PVC sole. Elastic toe. 5" high.

IC461SWHXX03000B SM-XL  
Carton Qty: 300EA (150 pairs)



### Frock - Tyvek® IsoClean®

Bound seams. Bound neck. Set sleeve. Snap closure (6 + 1 adjustable). Elastic wrists.

IC270BWHXX003000 SM-4X  
IC270BWHXX00300C SM-4X  
IC270BWHXX0030CS SM-4X



### Frock - Tyvek® IsoClean®

Serged seams. Bound neck. Raglan sleeve. Zipper closure. Elastic wrists. A-line.

IC264SWHXX00300B SM-4X  
IC264SWHXX00300C SM-4X  
IC264SWHXX0030CS SM-4X

\* NOTE: Please substitute your size for XX when ordering.

# DuPont Controlled Environments



**Frock – Tyvek® IsoClean®**  
Serged seams. High mandarin collar w/snap. w/snap. Set sleeve. Snap closure (6). Elastic wrists.  
IC263SWHXX00300B SM-4X



**Lab coat – Tyvek® IsoClean®**  
Laydown collar. Raglan sleeve. Snap closure (5). Pockets (1 left chest pencil, 2 lower front).  
IC224SWHXX00300B SM-2X



**Coverall – Tyvek® IsoClean®**  
Bound seams. Bound neck. Raglan sleeve. Zipper closure. Elastic wrists. Elastic ankles.  
IC182BWHXX002500 SM-4X  
IC182BWHXX00250C SM-4X  
IC182BWHXX0025CS SM-4X



**Shoe cover – Tyvek® IsoClean®**  
Serged seams. Elastic openings. Gripper™ sole. 5" high.  
IC451BWHXX01000B MD-XL  
Carton Qty: 100EA (50 pairs)



**Frock – Tyvek® IsoClean®**  
Bound seams. Full face opening. Bound hood opening. Ties with loops for fit.  
IC668BWHXX01000B  
IC668BWHXX01000C  
IC668BWHXX0100CS  
One size

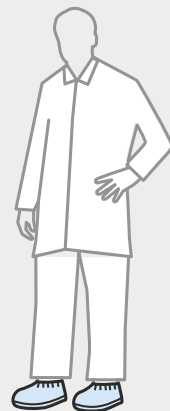


**Frock – Tyvek® IsoClean®**  
Integrated hood/mask combination. Bound seams. Bound head opening. Ties with loops for fit. White hood. Blue face mask. Pleated polyethylene outer 7" wide mask. Individually packaged.  
IC669BWHXX01000S  
One Size



\* NOTE: Please substitute your size for XX when ordering.

# DuPont Controlled Environments



**Shoe cover – ProShield® 30**  
Serged seams. Elastic openings. 5.5" height.  
PE440SBUXX020000 LG-XL  
Carton Qty: 200EA (100 pairs)



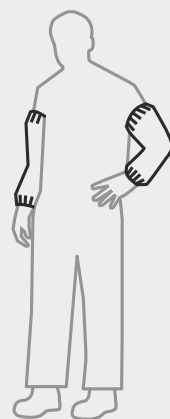
**Shoe cover – ProShield® 30**  
Serged seams. Elastic openings. 5.5" height.  
PE440SWHXX020000 MD-XL  
Carton Qty: 200EA (100 pairs)



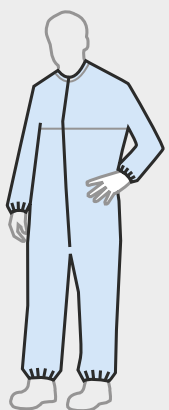
**Controlled environment mask – DuPont™ Sierra™**  
9" size. Bound Tyvek® ties. Pleated Rayon outer facing. Metal nose piece.  
ML7360WHXX0250BH  
ML7360WHXX02500S  
One size



**Boot cover – ProShield® 30**  
Serged seams. Elastic openings. Elastic ankles. 13" height.  
PE444SWHXX010000 LG-XL  
Carton Qty: 100EA (50 pairs)



**Sleeves**  
Bound seams. Elastic openings. 18" length.  
IC501BWHXX01000B  
IC501BWHXX01000C  
IC501BWHXX01000S  
IC501BWHXX0100CS  
One size



**Coverall – Tyvek® Micro-Clean® 2-1-2**  
Bound seams. Bound neck with loop at center back. Dolman sleeve. Zipper closure. Elastic wrists. Elastic ankles.  
CC252BBUXX00250S SM-5X  
CC252BBUXX0025PI SM-5X  
Made from Tyvek® brand flashspun polyolefin protective material. Coated on both sides with proprietary 2-1-2 blue polymeric resin. Antistatic treated. Garments available gamma sterilized to an SAL of 10-6. Traceability on all sterilized apparel.

\* NOTE: Please substitute your size for XX when ordering.



# Kevlar®

Gloves made with Kevlar® give you superior protection and maximum comfort

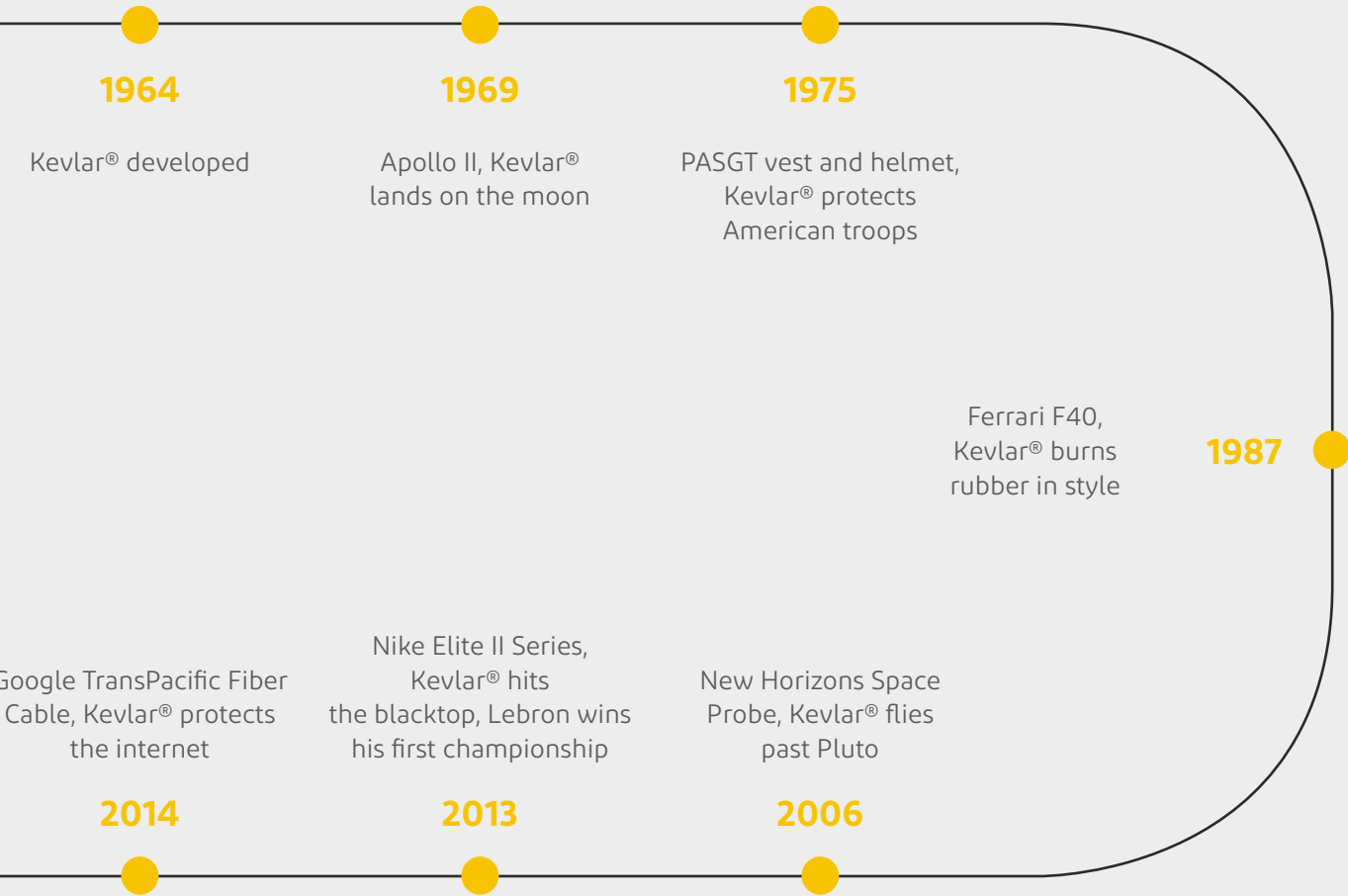


# What is Kevlar®?

Stephanie Kwolek developed the first liquid crystal polymer which provided the basis for DuPont™ Kevlar® brand fiber, an organic fiber in the aromatic polyamide family. Kevlar® has a unique combination of high strength, high modulus, toughness and thermal stability.

## A legendary product

Since its creation, Kevlar® has found its way into the history books and pop culture. The iconic material has saved over 3,000 lives and continues to help humankind achieve what was once thought impossible.



# Legendary protection

**5+ million**  
soldiers and police officers are protected by body armor made with Kevlar® every year

**1+ billion**  
pairs of gloves and sleeves contain Kevlar®



Kevlar® fiber has built-in heat and flame resistance



## The value of multi-hazard protection

Only Kevlar® fiber is designed to protect workers against multiple hazards they encounter on the job — for increased safety and peace of mind.



Cut



Puncture



Abrasion



Electric



Flame



High Heat



Grip



Welding



# Their safety is our job

Every glove and sleeve made with Kevlar® is more than just a promise of protection.



**Multi-Hazard Protection**  
Industry-leading cut performance with built-in heat, flame and arc flash resistance.



**Partnership**  
We work with our partners to provide the right level of protection for the task at hand.



**Comfort**  
Lightweight, highly breathable and less rigid—giving users the comfort they want.



**Peace of Mind**  
Lab-tested performance and a cross-functional team dedicated to supporting you.

## The right protection can make all the difference\*

**70%**  
of hand injuries result from not wearing any type of hand protection

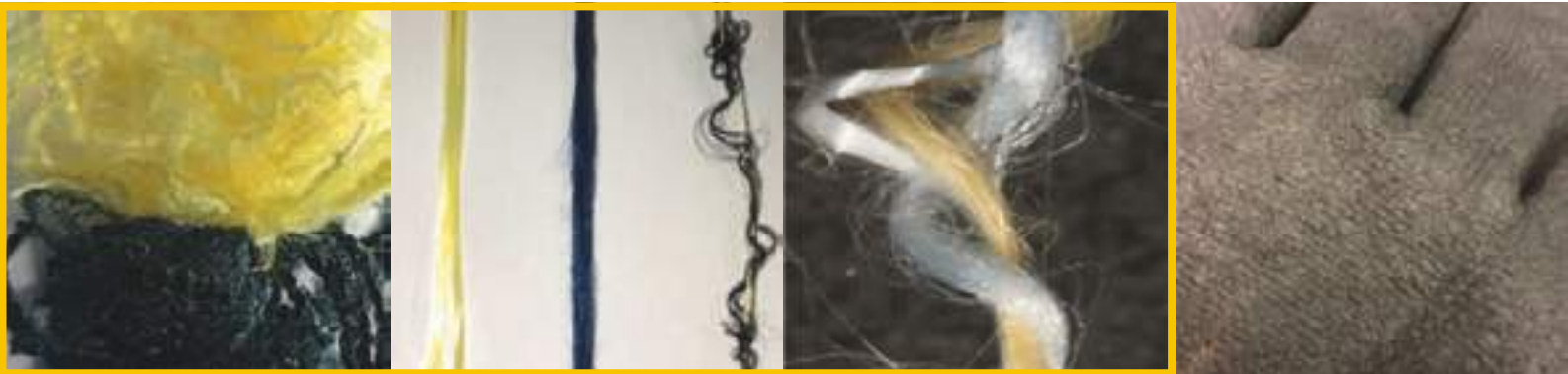
**30%**  
of hand injuries are caused by wearing the wrong glove

**20%**  
of disabling workplace injuries involve hands

# What makes up hand protection

The level of cut protection, reached by a glove, depends on many variables: material used in the liner, yarn construction and components and coating.

## The Power of Kevlar®



Fiber type	Yarn construction	Engineered yarns	Coating
	<ul style="list-style-type: none"><li>• Flat yarn</li><li>• Staple based spun yarn</li><li>• Textured yarn</li></ul>	<ul style="list-style-type: none"><li>• Fiber blends</li><li>• Reinforced with glass, steel</li></ul>	<ul style="list-style-type: none"><li>• PU</li><li>• Nitrile</li><li>• PVC</li><li>• Latex</li></ul>

## Keep protection and comfort intertwined

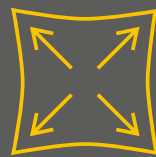
Patented Kevlar® engineered yarns are lightweight, highly breathable and less rigid—providing market-leading comfort and dexterity for the most intricate work.



Lightweight



Highly breathable



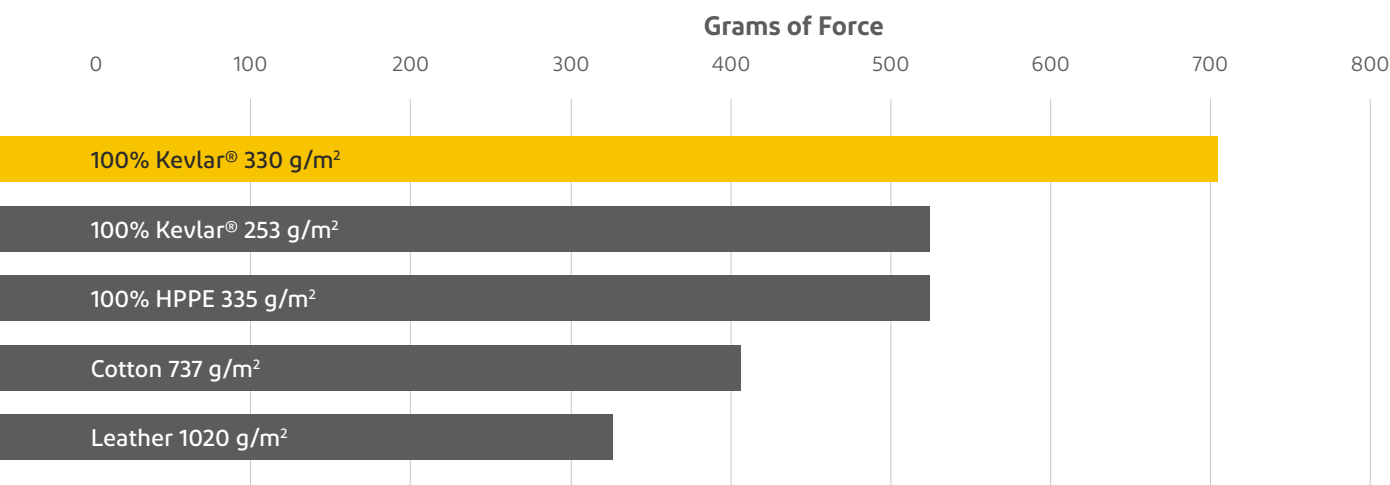
Flexibility



Dexterity

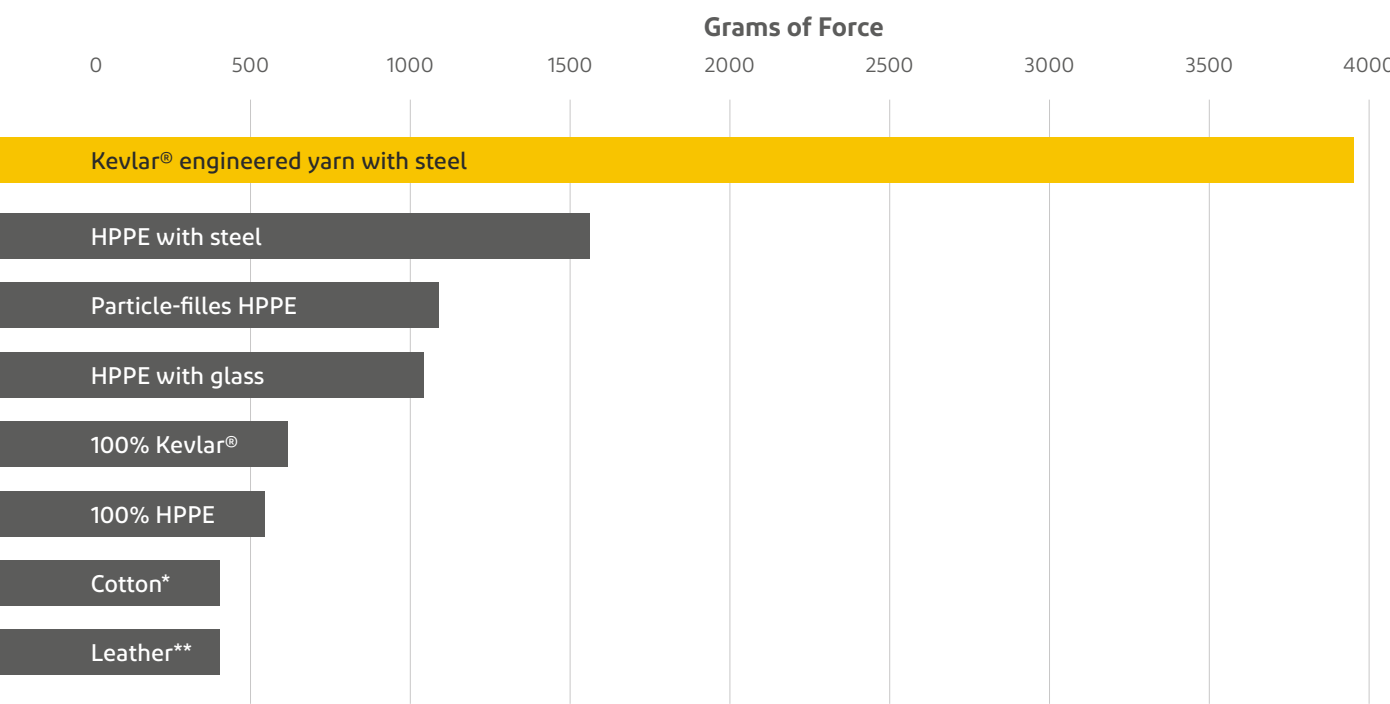
# Protection that’s a cut above

Kevlar® provides at least 30% higher cut resistance on an equal weight basis. Kevlar® can also be 25% lighter while providing the same level of cut resistance as competitors, for enhanced user comfort.



Test method: ASTM 2992

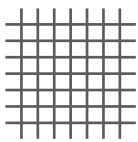
Kevlar® engineered yarn with steel has superior cut performance compared to competitors’ engineered yarns.



Test method: ASTM 2992. All knit glove liners. normalized to 295 g/m2, unless noted

# Protection only works when it’s worn

With 70% of workplace injuries resulting from workers not wearing gloves, new Kevlar® engineered yarns offer increased comfort without sacrificing protection—so workers won’t want to take them off.



## 50% lower liner weight

Lower areal density correlates with lower weight and higher comfort



## 2x higher air permeability

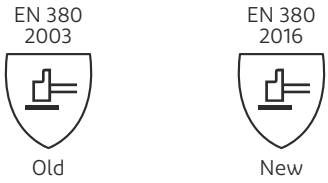
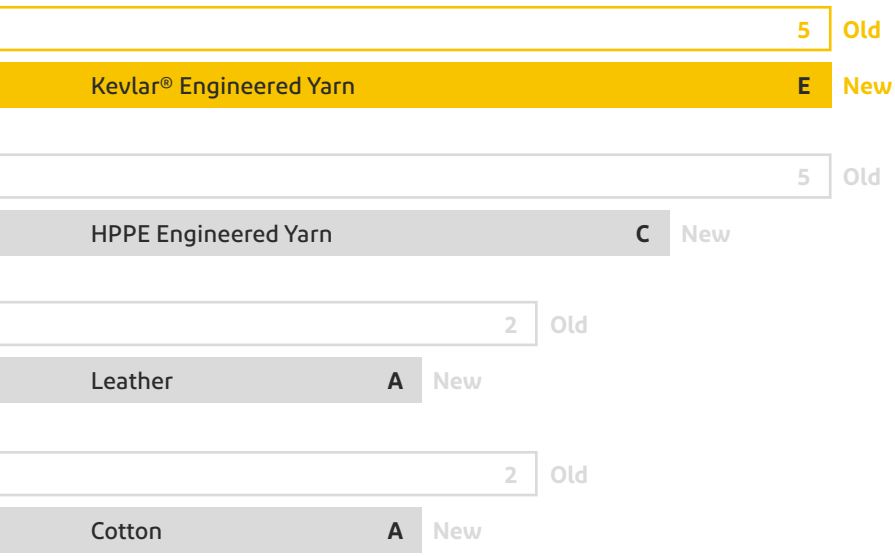
Lightweight, highly breathable and less rigid—giving users the comfort they want.





New standards. Consistent protection.

Only Kevlar® kept or increased its protection with the updated EN 388—2016 Standard.



Kevlar® can also take the heat

100% Kevlar® is inherently flame resistant and doesn't ignite, melt or degrade in heat.

HPPE (UHWPE) starts to decompose above 400°C.

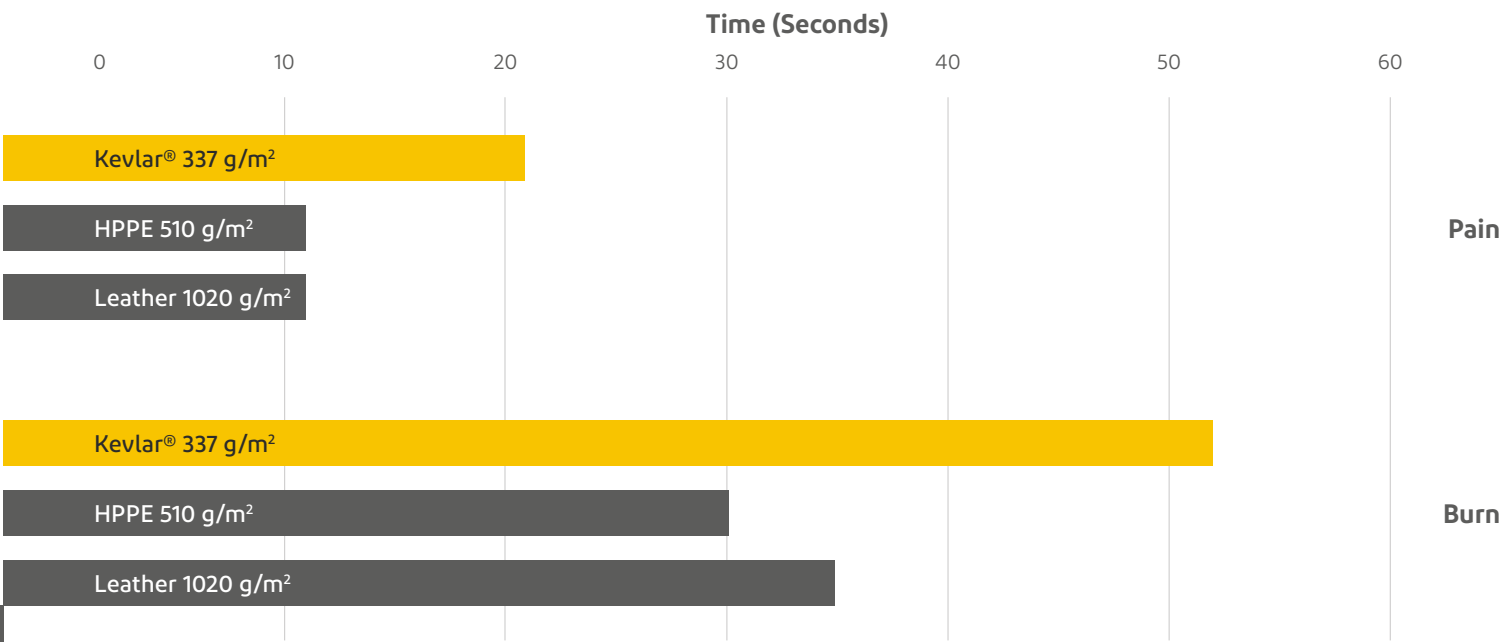
HPPE is not recommended for prolonged use above 70°C and has a melting point of 130°C.

	Melt Point	Decomposition
100% Kevlar®	-	800-900°F (472-482°C)
100% Nomex®	-	700-800°F (371-427°C)
Polyamide 6.6 (PA6.6)	480-500°F (249-260°C)	-
Polyester	470-490°F (243-254°C)	-
Polyamide (PA6)	420-430°F (216-221°C)	-
Rayon	-	325°F (163°C)
HPPE (UHWPE)	280-300°F (138-149°C)	-

Because every second counts

Kevlar® provides a 70% longer time to pain and burn vs. HPPE at a 50% lighter weight.

100° C Contact Temperature



Test method: ASTM F1060

Multiple hazards. One solution.

Kevlar® delivers industry-leading multi-hazard protection and meets the standards for:



# Setting the standard



## ISEA 105/EN388

Solutions engineered with Kevlar® are designed to meet a range of requirements from low cut to the highest cut level requirements—providing a full spectrum of offerings that satisfy the latest ANSI 105:2016(A2-A9) and EN388:2016 (B-F) standards.

## NFPA 2112

100% Kevlar® offerings enable compliance with the recently updated 2018 version of NFPA 2112, which now requires gloves to comply with the flame resistant standard. This includes compliance with no melt/no drip and heat transfer/resistance/ shrinkage requirements.



## ISEA 105/EN407

100% Kevlar® has unique product performance capabilities. It resists thermal degradation and doesn't ignite, melt or drip. It passes the highest levels of contact heat before receiving pain or 2nd degree burns. 100% Kevlar® only decomposes at >800° F (427° C).

## NFPA 70E

Kevlar® can be used as a component and enabler to meet arc flash standard requirements due to its inherent flame and heat resistant properties.

# Make innovation our common thread

Kevlar® engineered yarns continue to allow our partners to redefine what's possible when it comes to protection. Every year, the latest advancements are presented with the DuPont™ Kevlar® Innovation Award.



# The possibilities are endless

From the oil field to the battlefield, our partners continue to take protection to new heights with Kevlar® engineered yarns. In the last 5 years alone, 35 Innovation Award winners have been introduced —pushing the boundaries of cut and heat protection and arc flash and puncture resistance.

# Kevlar® provides long-lasting value

Gloves made with Kevlar® retain their cut performance after laundering, which means fewer replacements without losing performance.

**Gloves of 100% Kevlar® can last up to 10 cleaning cycles**





# Nomex®

Garments made with Nomex® for flame  
and arc protection



# What is Nomex®?

DuPont™ Nomex® is a heat- and flame-resistant meta-aramid fiber used across a diverse range of applications – perhaps most commonly known as a key component in fabrics utilised to create **protective apparel**. Due to its unique combination of heat, flame and electric arc protection, durability and comfort, the Nomex® brand is trusted amongst those working in dangerous conditions such as firefighters; military pilots and combat vehicle crew; auto racing drivers, pit crew and track officials; and industrial workers at risk from **flash fire** and **electric arc hazards**.

Inherently flame resistant, Nomex® offers supreme strength and heat performance versus many other products on the market. It doesn't melt, drip or support combustion in the air. A key factor in the protection provided by Nomex® is its ability to carbonize and thicken when exposed to intense heat. This typical reaction increases the protective barrier between the heat source and the wearer's skin and minimizes burn injury. As the protection is engineered into the molecular structure of the Nomex® fiber (as opposed to chemical treatment), the heat and flame resistance will last the lifetime of the garment – the protection cannot be washed out or worn away.

# Trusted Protection

DuPont™ Nomex® offers a level of protection that meets or exceeds the norms differentiating it from its competitors. Instead of being treated with a flame-retardant substance, Nomex® is inherently flame-resistant due to its specific molecular structure. Its thermal protection performance cannot be affected by washing, abrasion or exposure to heat.

## Thermal Protection Performance

Nomex® shields the wearer from heat and flame and protects him from body burns. In DuPont™ Thermo-Man® tests, typically lighter Nomex® garments demonstrate up to 35% less 2nd and 3rd degree body burns than typically heavier flame retardant (FR) treated cotton garments after an exposure of 4 seconds, as recommended by EN ISO 11612. Wearing protective clothing made of DuPont™ Nomex® considerably increases a victim's survival chances.

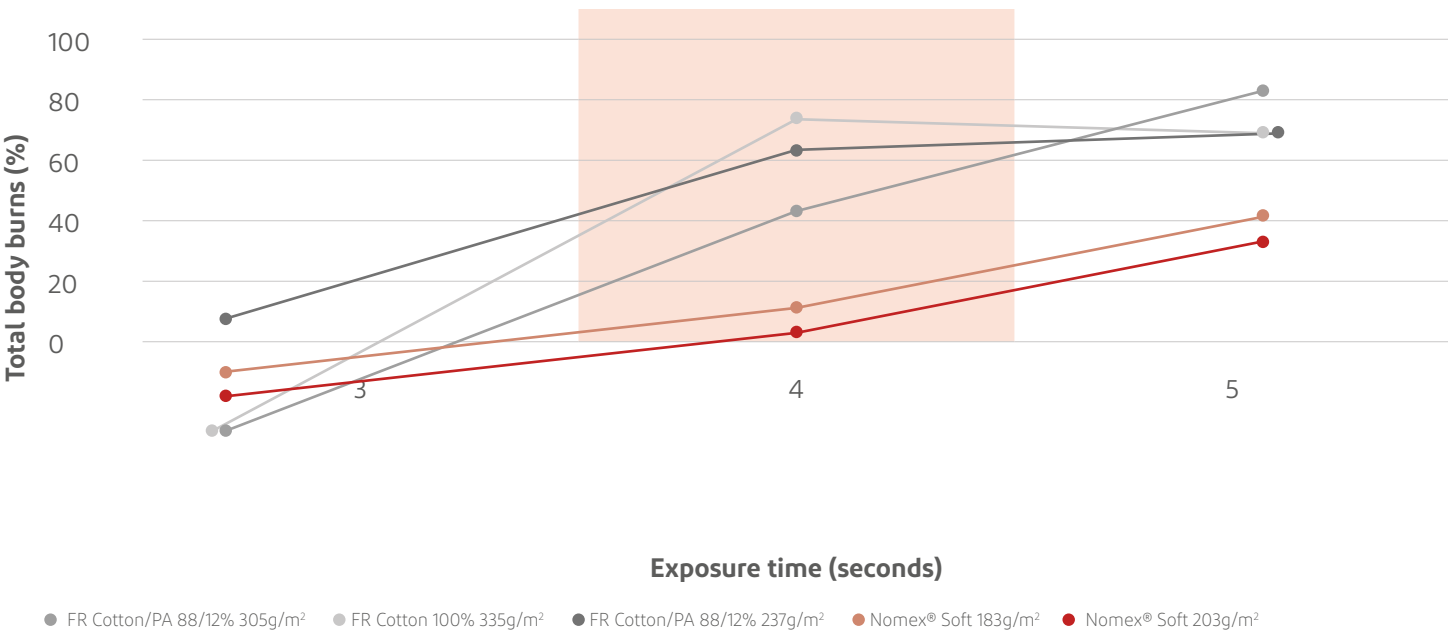
## Nomex®: A synthetic fiber for coverall, gloves, suits & more

Nomex® PPE garments are created using Nomex®-based fabric, stitched together with Nomex® thread, providing optimal protection for the wearer against multiple hazards. This includes items such as: coveralls, protective gloves, suits (multi-layer jackets and trousers), balaclavas, hoods, trousers, tops and underwear (non-melting).

Furthermore, the latest Nomex® innovative solutions show similar or even better arc protection values than heavier flame retardant cottons, allowing an excellent performance/weight ratio for single and multi-layer garments.

# Trusted Protection

## Thermal Protection Performance



Tests are conducted according to ISO 13506 on standard coveralls (same style and size worn together with standard short sleeve cotton underwear) which are exposed to heat energy levels of 84 kW/m².

## After 4 seconds' Thermo-Man® Exposure





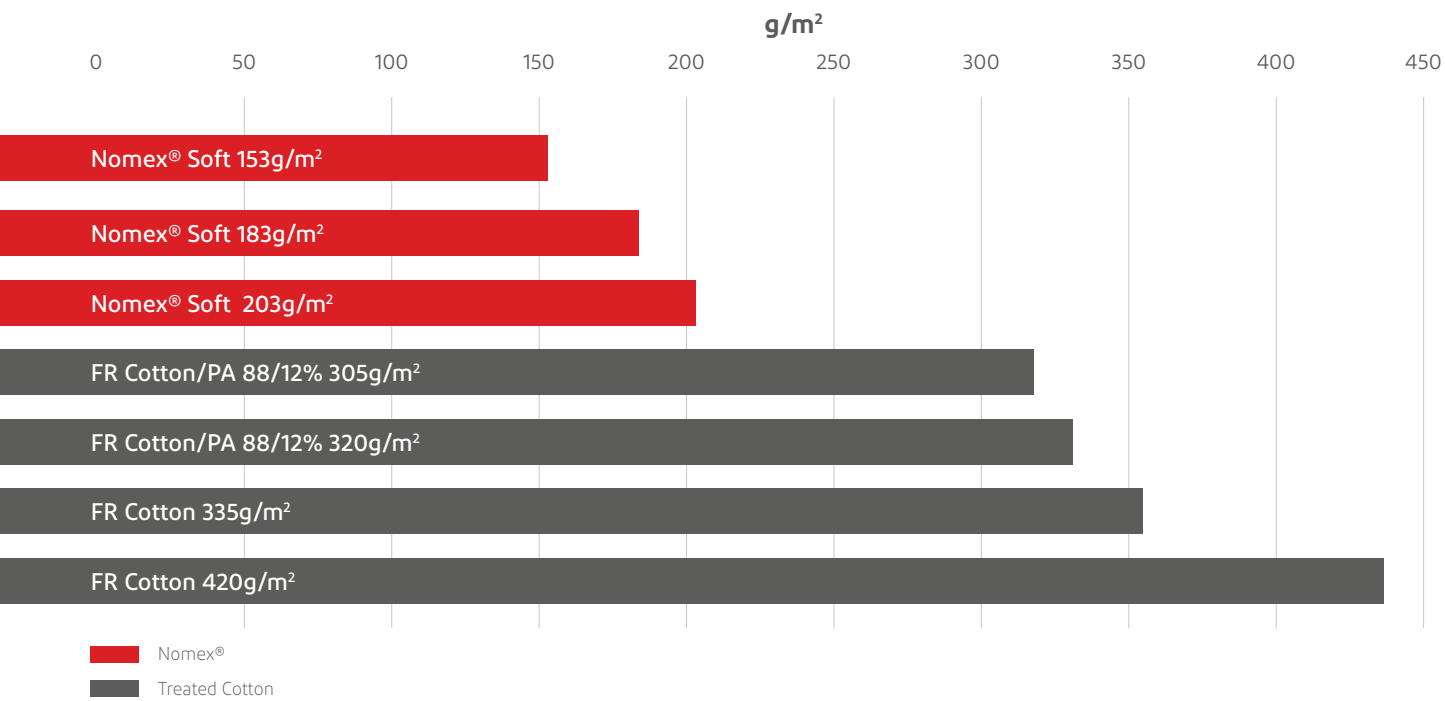
Wearer’s Comfort

What feels comfortable may differ from person to person, but one thing is certain: if a garment is uncomfortable, it detracts from the wearer’s ability to work efficiently, or may not be worn at all.

DuPont™ Nomex® innovative fabrics and garments are designed by experts with this in mind.

Fabric weight

Basis weight of industrial PPE fabrics



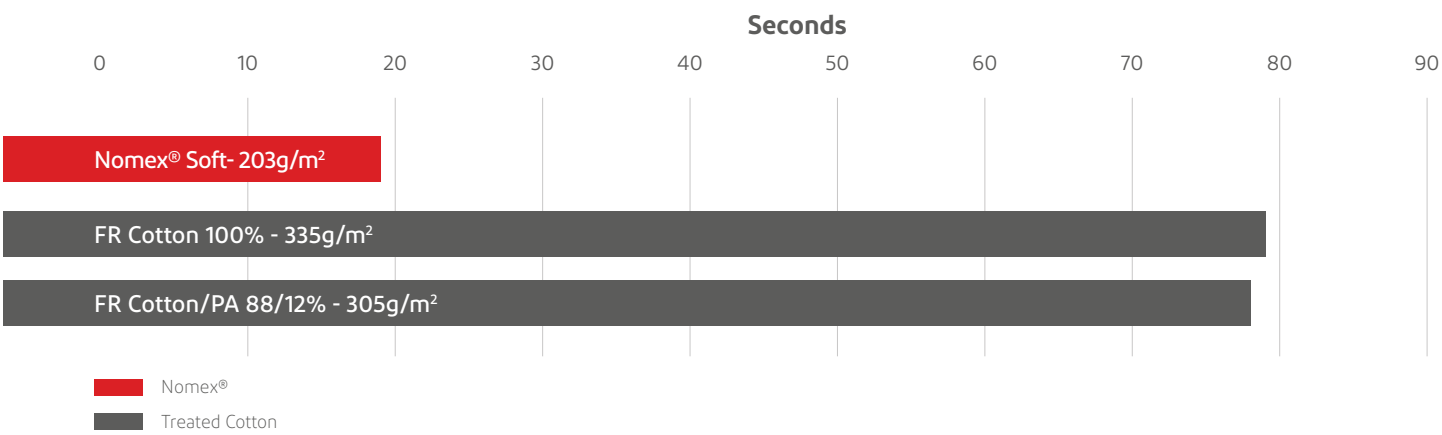
Weighing between 150 and 265g/m², typical Nomex® solutions are up to **40% lighter** than FR cotton and cotton blend fabrics, and therefore **more comfortable** to wear.

Wearer’s Comfort

DuPont™ Nomex® fabrics and garments enable **lightweight** solutions with **excellent moisture management**.

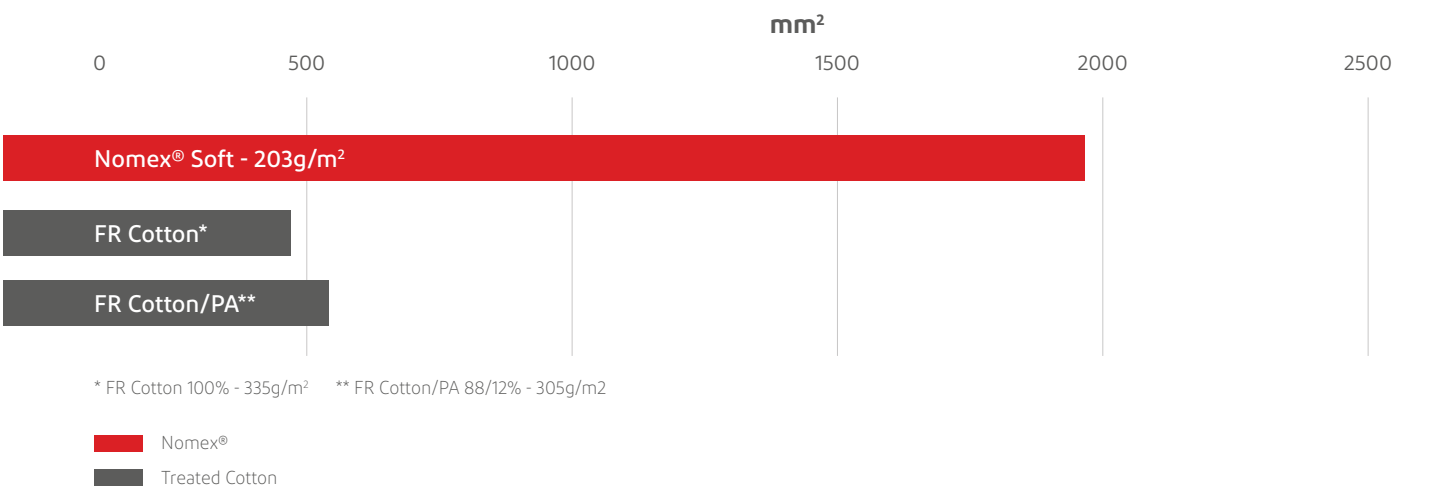
Moisture management

Sweat wicking time



Moisture management

Sweat propagation after 1 minute



Innovative Nomex® fabrics dissipate sweat much more quickly than other solutions, **making the wearer feel dry and more comfortable**.

Cost-Effectiveness

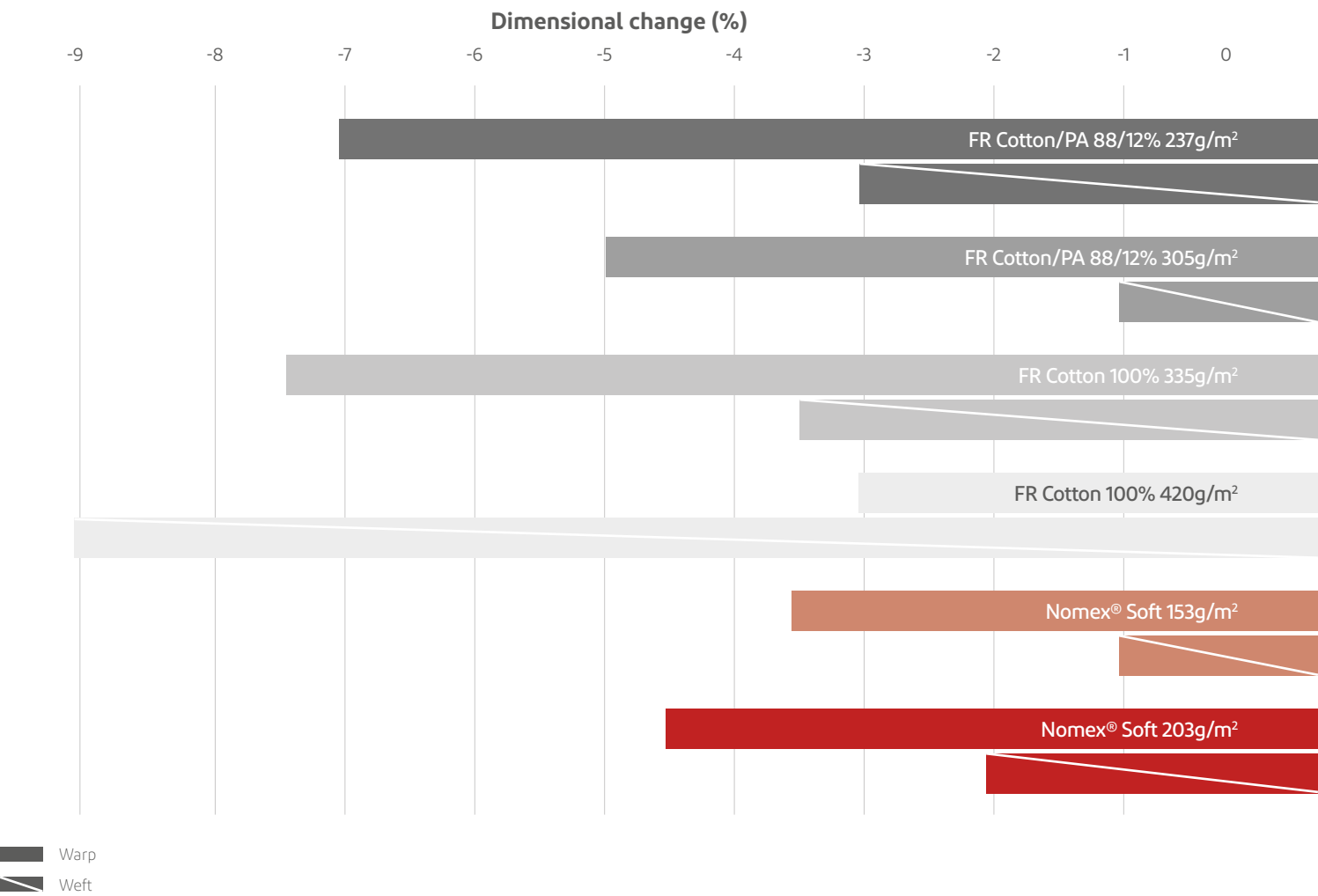
DuPont™ Nomex® is a highly cost-effective solution in terms of cost per wear thanks to its exceptional durability.

Nomex® garments offer better strength and lower shrinkage after washing and drying than FR cotton. This leads to an excellent professional appearance over a longer lifetime.

Suitable for home or industrial laundry, Nomex® garments retain their inherent benefits throughout many washes, guaranteeing the same level of protection throughout their service life.

Less shrinkage

Dimensional change after 50 wash cycles



Nomex® shows excellent performance in shrinkage compared to FR cottons, contributing to a higher durability of garments.

Frequently Asked Questions

1. Why is inherent protection important to me?

The FR properties of inherent fabrics will not decrease over time. This means the FR properties of garments made of inherent fibers cannot be compromised. It also means that garments made of inherent fibers like Nomex® are expected to last at least twice as long as non-inherent FRT garments made of treated cotton or cotton blends.<sup>1</sup>

2. What does “inherent for the life of the garment” mean?

Unlike non-inherent flammable materials that get a topical treatment to become flame-retardant, inherent fibers are flameresistant through and through—down to the molecular structure of each fiber—so the protection will not decrease over time from wear or washing. The thermal protection lasts for the life of the garment.

3. How can FR properties be removed from a garment?

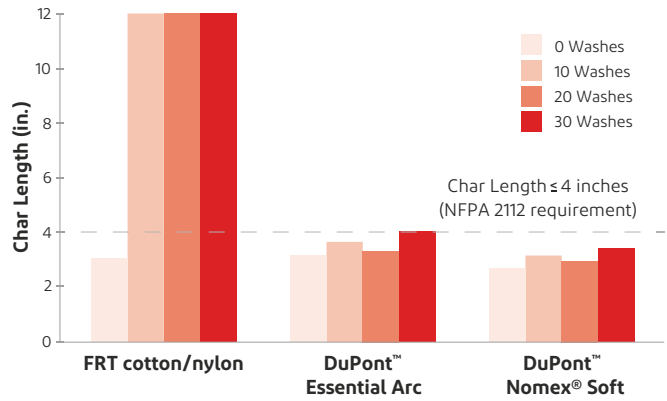
For post-treated fabric, such as FRT cotton or FRT cotton/nylon blends, one way to remove FR properties is to use regular chlorine bleach while washing the garment. Char length test results shown in Figure 2 demonstrate this.

The vertical char length test (standard ASTM D6413) is one of the key tests used to qualify fabrics as flame-resistant. In this test, a 12-inch strip of fabric is hung vertically and exposed to an open flame at the bottom of the fabric for 12 seconds. The length of fabric char is measured in inches. To meet the NFPA 2112 certification standard, the length of char damage up the fabric must be less than or equal to 4 inches.

As shown in Figure 2, the FRT cotton/nylon fabric passed this requirement when new (0 washes), but after 10 washes with regular detergent and chlorine bleach, its char length had increased to 12 inches (the entire length of the sample burned). Although use of chlorine bleach may not be recommended per some fabric manufacturers’ laundry instructions, this can happen in the real world. It does not take many washes with chlorine bleach to damage the FR properties of a non-inherent FRT cotton or cotton/nylon fabric. And, unfortunately, the wearer would not be able to tell if a garment was no longer flame-resistant simply by looking at it.

With inherent fabrics, the FR properties cannot be removed. As shown in Figure below, Nomex® Soft and Protera® fabrics continue to meet the NFPA 2112 requirements for char damage length even after 30 washes with detergent and chlorine bleach (laundered and tested in the same way as the non-inherent fabric).

Char length test results of fabrics before and after laundering with chlorine bleach.



Notes: Fabrics were all home-laundered using household detergent and chlorine bleach, using common home laundering procedures. Char length is the length that is damaged when 12 inch long fabric samples are tested using ASTM D6413 method. Fabric softeners, dryer sheets or other laundry aids should not be used to launder FR or FRT garments if they contain flammable materials.

4. I have seen that some non-inherent FRT garments should not be dry cleaned or laundered with chlorine bleach, oxygen bleach or hydrogen peroxide. Are these cleaning methods a problem for inherent fibers like Nomex®?

Because Nomex® fiber is inherently flame-resistant, there is no coating that can be damaged by dry cleaning or laundering with chlorine bleach, oxygen bleach or hydrogen peroxide. Exposure to chlorine bleach will not affect the FR properties of inherent fabrics like Nomex® Soft, Nomex® MHP and Protera®. However, repeated use of chlorine bleach in the laundry is not recommended for garments made of Nomex® because chlorine bleach can cause fabric color to fade and fabric strength to weaken, which may shorten the useful wear life or affect the appearance of a garment.

<sup>1</sup>Source: Bulwark Industry Update, Volume 16, 2014.



Frequently Asked Questions

5. How would I know if the FR properties of a non-inherent FRT garment have been compromised?

Without performing destructive testing, such as the vertical char length test, you would not know. This is dangerous because the wearer cannot see the difference between a non-inherent chemically treated garment that is still effective and one that has lost its FR properties.

6. When should I retire my FR garments from service?

Any garment with visible holes, rips, tears, soils, stains or contamination from flammable materials should be properly repaired, cleaned or removed from service. However, it is difficult to judge the remaining level of flame resistance in a post-treated FRT garment because there are no visible clues to indicate whether the FR protective coating is still there without performing destructive testing. Therefore, a garment made with non-inherent chemically-treated FRT fabric, such as FR cotton/nylon blends, may need to be retired from service because its FR chemical treatment was compromised, long before the fabric shows any visible wear. However, the wearer would not know this because the garment would show no indication of this compromise in FR protection.

In contrast, because the FR properties of a truly inherent FR fabric do not change with use or laundering, the FR properties of Nomex® Soft, Nomex® MHP and Protera® will remain no matter the garment age or how it was laundered.

7. If inherent FR garments and non-inherent FRT garments perform differently, how can they both be certified to the same standard?

The two main garment performance standards for FR clothing, NFPA 2112 and ASTM F1506 (used for NFPA 70E®), only specify minimum performance levels for fabrics and garments. These standards do not address all factors related to durability of the FR properties. It is the end-users' responsibility to determine if these minimum standards provide an appropriate performance level for their particular application.

8. What if I need electric arc protection?

Garments made of Nomex® MHP and those made of Protera® are specifically designed to protect against electric arc hazards as well as fire exposure. Both products offer lightweight protection using inherent fibers. Garments made of Nomex® MHP and those made of Protera® will retain their professional appearance throughout extended use and proper launderings, and demonstrate a better lifecycle value than less durable FRT cotton and FRT cotton/nylon blend garments.



DuPont™ Nomex®:

key benefits for protective apparel

Inherently flame resistant, does not melt or drip

Contains no chemical treatment, halogens or heavy metal

High thermal protective barrier

High mechanical strength

Lightweight comfort

Dry feeling

Permanent antistatic properties

Better professional appearance over its lifetime after washing

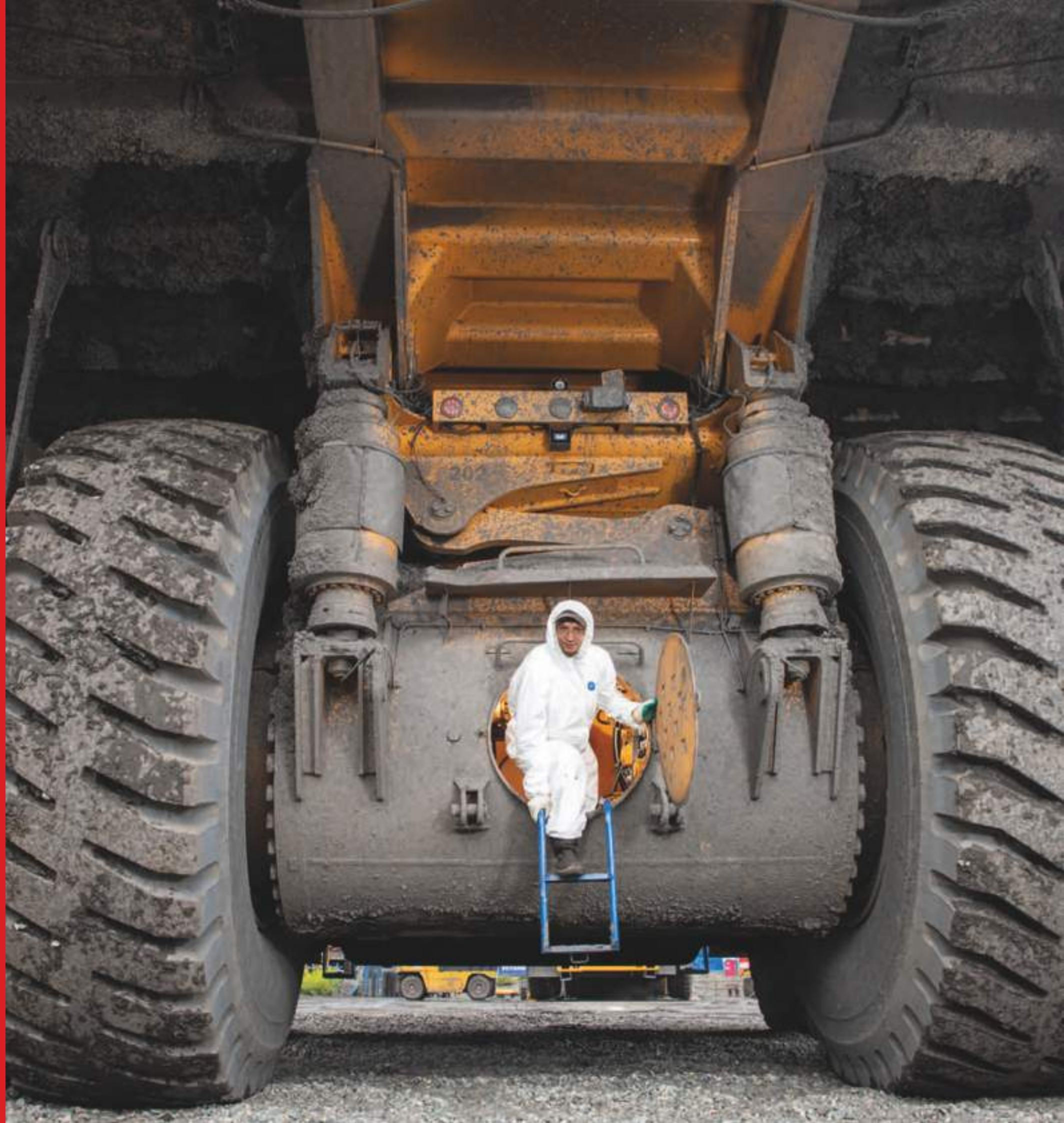
Backed by accredited testing laboratory

Quality assurance with selected partners throughout value chain





# Appendices







## 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

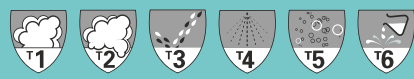
Step  
1

Hazard identification



Step  
2

Determine minimum levels of protection needed



Step  
3

Assess hazard toxicity



Step  
4

Determine protective performance requirements of the fabric and seam



Determine mechanical performance requirements



Comfort considerations



Supplier selection



Identify the correct usage of the product



Wear test

Step  
5

Step  
6

Step  
7

Step  
8

Step  
9

Appendices

The 9-step guide from DuPont to garment selection

Step  
1



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.

Hazard identification

This risk analysis might take the following form:

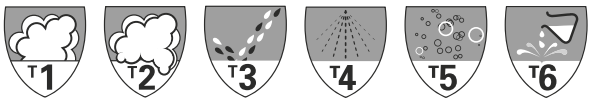
1. Objectively identify the potential hazards including their sources and any associated trigger events. A suitable hazard assessment form or software package might be used for this purpose.
2. Determine those who might be affected by exposure to a hazard and in what circumstances.
3. Evaluate the risks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

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

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



Step  
2



Determine minimum levels of protection needed

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

Step  
3



Assess hazard toxicity

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](http://www.safespec.dupont.co.uk).

Step  
4



Determine protective performance requirements of the fabric and seam

Fabric

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

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

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

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

Seam construction

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

Step 5



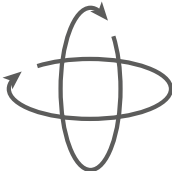
Determine mechanical performance requirements

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).

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.

Two important factors that contribute to protection-in-use (and overlap with comfort and ease-of-use considerations are garment sizing and garment fit (please see donning and doffing videos). The correct size and cut of a protective coverall has a huge impact on the protection provided to the wearer and is a significant

Step 6



Comfort considerations

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

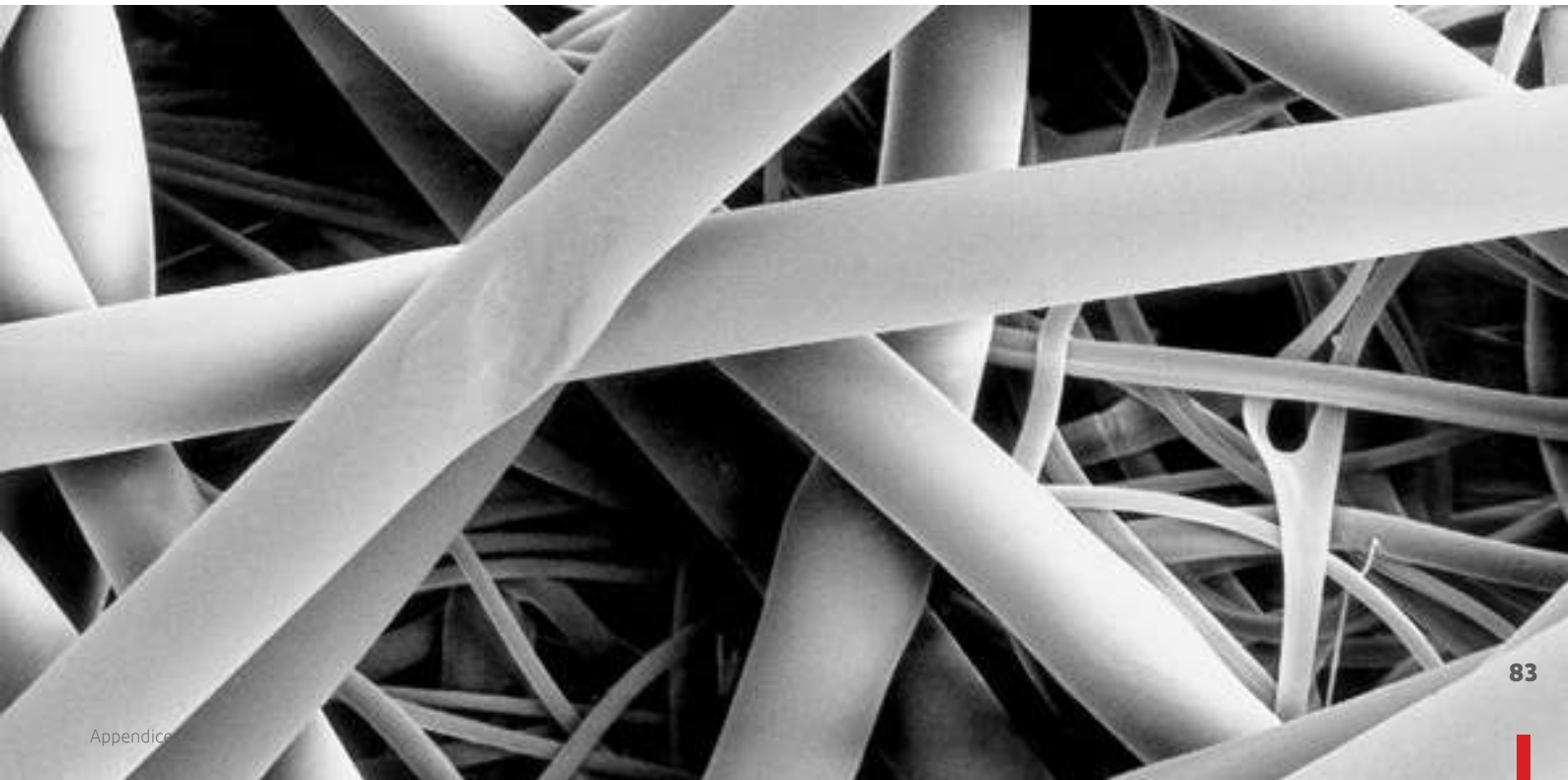
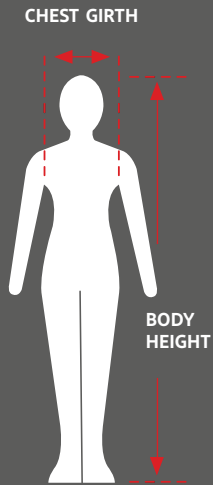
doesn’t fit or if it isn’t comfortable then it is often being worn incorrectly. Identifying the appropriate protective and mechanical performance, yet, at the same time, maximising wearer comfort is a critical part of the selection equation and will significantly contribute to correct overall use with 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.

Garment style

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

Body measurements cm/inch

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





The 9-step guide from DuPont to garment selection

Step 7

Supplier selection

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

The 9-step guide from DuPont to garment selection

Step 8

Identify the correct usage of the product

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

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



Wear test

A detailed examination of technical performance data and product standards is only the first part of the product selection process. Once a product has been selected which meets the required performance criteria on paper it is then important to conduct ‘in-use’ wear trials to test and evaluate the product performance in use. This will include using the garments part of an appropriate PPE ensemble to ensurefull ‘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.


Step 9

Recommended donning & doffing procedures from

DuPont for chemical protective clothing

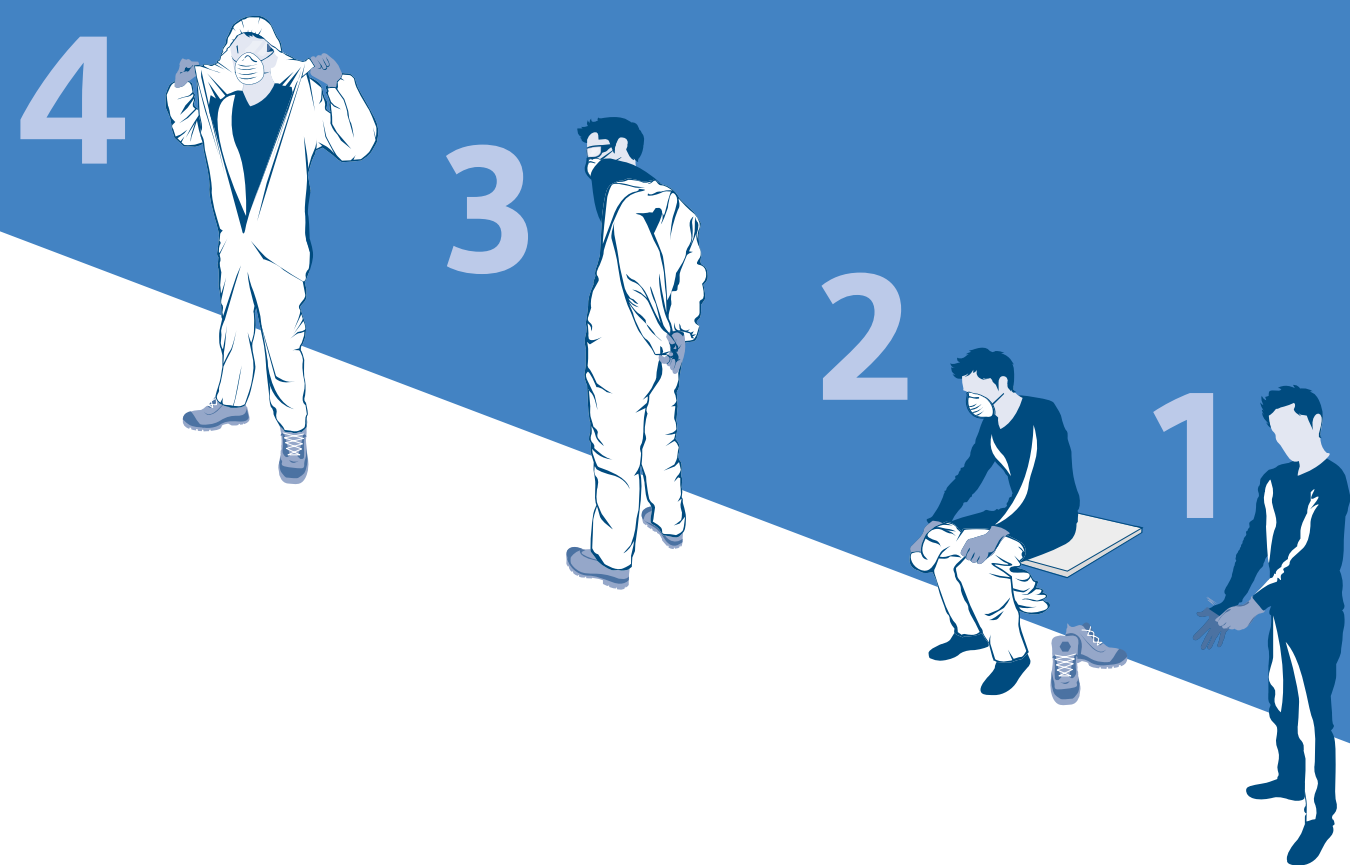
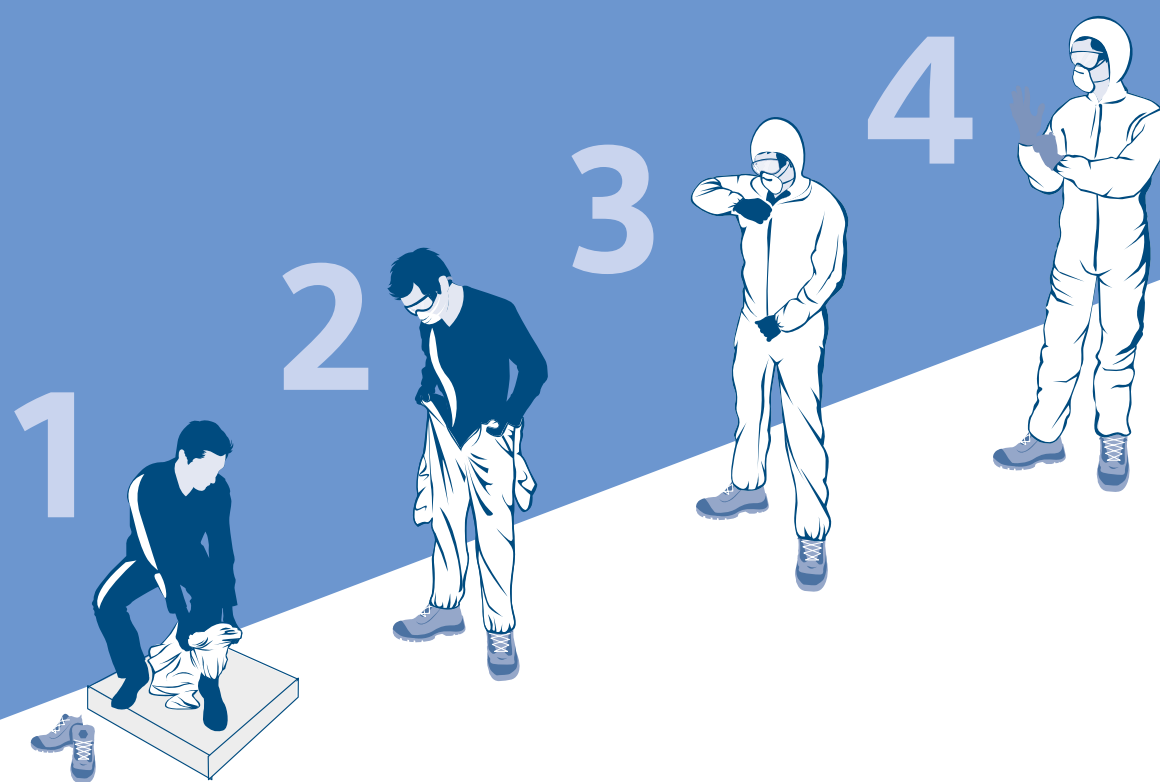
Follow the steps recommended below to dress and undress in a safe and simple manner, thereby limiting any potential for contamination after working in a hazardous environment.

Typical products following this procedure:  
Tyvek® 500 Industry, Tyvek® 400 Dual, Tyvek® 500 Xpert, Tyvek® 500 Labo, Tyvek® 600 Plus

84 - 92	92 - 100	100 - 108	108 - 116	116 - 124	124 - 132	cm	
SM	MD	LG	XL	2XL	3XL	SIZE	
162 - 170	168 - 176	174 - 182	180 - 188	186 - 194	192 - 200	cm	

Donning

Doffing





Product Part Numbers

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

TY	120	S	WH	LG	0025	00
Fabric	Style	Seam Construction	Color	Size	Case Count	Options
<p>The first two characters are the fabric description.</p> <p>Abbreviations</p> <p>DuPont™ Tychem®</p> <p>TK 10000</p> <p>TP 6000 FR</p> <p>TF 6000</p> <p>TYF 6000</p> <p>SL 4000</p> <p>QC 2000</p> <p>99 Accessories</p> <p>DuPont™ Tyvek®</p> <p>TJ 800 J</p> <p>TY 600</p> <p>TY 500</p> <p>TY 400</p> <p>TD 400 D</p> <p>DuPont™ ProShield®</p> <p>PS 60</p> <p>PS 20</p> <p>PS 20 SFR</p> <p>PS 8 Proper</p> <p>PS 4 Practik</p>	<p>DuPont offers a wide array of garment styles—from hoods, aprons and coveralls to fully encapsulated suits. Each garment style has a unique three-digit code.</p>	<p>Abbreviations</p> <p>S Serged or Sewn</p> <p>B Bound</p> <p>T Taped or Double Taped</p> <p>See page 15 for details.</p>	<p>Several DuPont fabrics are available in color options.</p> <p>Abbreviations</p> <p>BU Blue</p> <p>GR Green</p> <p>GY Gray</p> <p>LY Lime Yellow</p> <p>OR Orange</p> <p>SV Silver</p> <p>TN Tan</p> <p>WH White</p> <p>YL Yellow</p>	<p>Many DuPont garments are available in a range of sizes; refer to catalog descriptions for details.</p> <p>Abbreviations*</p> <p>SM Small</p> <p>MD Medium</p> <p>LG Large</p> <p>XL Extra large</p> <p>2X 2 Extra large</p> <p>3X 3 Extra large</p> <p>4X 4 Extra large</p> <p>5X 5 Extra large</p> <p>6X 6 Extra large</p> <p>7X 7 Extra large</p> <p>00 Universal</p> <p>See page 16 for sizing charts.</p>	<p>The number of garments per case.</p>	<p>Abbreviations such as</p> <p>TV Trade Agreement Act compliant</p> <p>VP Vend packed</p> <p>Not all option codes are available for all products; refer to catalog descriptions for details.</p> <p>See next page for abbreviations.</p>

Stock Items versus Make to Order for ProShield® and Tyvek® garments, sizes Medium to 4 Extra Large are identified as stock items. Sizes Small and 5 Extra Large and above are identified as Make to Order. Certain accessory items are also identified as Make to Order.

Most garments in the Chemical/HazMat line (Tychem® 2000, Tychem® 4000, Tychem® 6000, and Tychem® 10000) are identified as Make to Order. A small grouping is identified as stock items, following the same size guidelines as indicated above.

\* Not all sizes are available in all styles.

Product Part Numbers

Option code abbreviations

00	Standard offering	G1	Reduced case quantity
0B	Bulk pack	JF	CPE sleeve cuff and jam fit glove insert
2K	Double storm flap w/zipper & hook-and-loop closure	LG	8.25" high shoe cove
5C	Showa Best® 892 outer glove	NF	NAFTA sourced
5V	Showa Best® 890	NP	Respirator fit hood and storm flap
7C	MSA connector pass-thru CAMDS (#491335) right side	NS	Non-skid material
7M	MSA dual purpose w/Foster fitting 990060	PI	Packaged individually
7N	MSA quick fill w/Schrader fitting 990190	SR	Skid-resistant
7R	MSA dual purpose #495670 Hansen fitting (left front waist)	TV	Trade Agreement Act compliant
7S	Scott® pass-thru #803620-01 Hansen fitting (right side)	VP	Vend packed
7W	Interspiro pass-thru #33689006	WG	With gloves
BN	Berry Amendment compliant		

Option codes for Tyvek® IsoClean® garments\*:

CS	Clean and Sterile: clean-processed, individually packaged and sterilized by gamma radiation
00	or 0B Bulk packaged
0C	Clean: clean-processed, individually packaged
0S	Sterile: individually packaged and sterilized by gamma radiation
PI	Individually packaged in an opaque bag

\*See pages 60-67 for Tyvek® IsoClean® garments.

# CE markings, European standards and legislative framework

## Duty of care

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

and liability under certain national laws such as the UK Health and Safety at Work etc. Act 1974.

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

# CE markings, European standards and legislative framework

- Compliance with a standard, while generally representing a minimum acceptable quality level, can confer unwarranted credibility and status to companies and products that are not necessarily of a good merit. An ‘ISO’ certificate, for example, is, in itself, no guarantee that a company manufactures superior quality products. It merely proves a degree of procedural compliance and this can be a misleading indicator.
- A blind adherence to standards can mitigate against the application of ‘common sense’ in situations where this is more appropriate.
- Due to their universality, international standards can be open to interpretation since they are enacted across many states (for example, in the case of CE marking, these apply across the entire 31 member states of the European Economic Area).
- International harmonisation results in an ‘approximation’ of existing national laws and can result in a dilution of some national standards which is detrimental to overall levels of safety.
- Users and specifiers can be lulled into a false sense of security by an over-reliance on published technical standards. The use of standards can lead to ‘decision abrogation’ and ‘accountability transfer’ effects due to a myopic over-reliance on the perceived safety attributes of ‘certified’ products.
- Compliance with standards, especially those involving inordinate amounts of paperwork or high financial outlays, can divert resources away from improving genuine quality and safety issues.
- By practical necessity, standards tend to be data-driven and based on ‘recognised test methods’, i.e. laboratory tests and simulations, and do not necessarily take into adequate account the real life and in-service aspects of product usage.
- Similarly, many standards are based on a necessarily limited amount of data and risk scenarios which reduces their applicability to all hazard situations.

Standards, therefore, supplement but are no substitute for a thorough assessment of hazards and the protective options available. All this, however, is not to downgrade the importance of standards. They are absolutely vital tools in establishing minimum safety and quality performance, of ensuring product and process consistency and repeatability, and in establishing cross-industry and cross-market compatibility. It is, however essential to be aware -of their limitations and never use them as an excuse for not conducting a proper evaluation of protective garments or any other PPE.

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

- Standards, and international standards in particular, take a long time to develop, agree and harmonise. The requirement for lengthy consultation periods adds to the problem. The same applies to their subsequent review and revision. This means that standards tend to be quickly out of date and out of line with technological developments, modern safety criteria and the latest scientific knowledge in the market place.
- Although some standards may be performance-driven, as opposed to specification-driven, and are claimed to be flexible enough to be independent of technical progress, in practice the “lowest common denominator” effect of standards can serve to mitigate against innovation and creativity. Their prescriptive nature tends to force manufacturers along set paths when there may be other options and solutions that are as good, or better than those dictated by a prescriptive standard.



# CE markings, European standards

## and legislative framework

### Mandatory Standards

EU directives such as former Council Directive 89/686/EEC1 and new PPE Regulation (EU) 2016/425 governing personal protective equipment that is placed on the market, are required to be embraced by companies operating in EU and EEC member countries and enshrined in national law. Such legislation is designed to facilitate the free movement of goods within the Community and ensure that certain basic health and

safety requirements are met to protect the end-user (the ‘essential requirements’). The general scope of EU Directives/Regulations such as this tends to be wide in nature and ranges from clothing and respiratory protective masks to safety footwear and fall arrest equipment. There are only a very few exclusions to this Directive and these generally relate to specialised equipment already covered by EU legislation.

### ISO

An EN standard is essentially a regional Standard. Increasingly, however, European Standards (prefixed EN – European Norm) are being superseded, subsumed or harmonised with International Standards (prefixed ISO). ISO is the International Organization for Standardization

which works to develop and translate standards at an international level. There is much co-operation and mutual adoption between ISO and the EU and mutually adopted standards bear the prefix ‘EN-ISO’.

### CEN

CEN (Comité Européen de Normalisation) is the European Committee for Standardization and is the non- profit body officially vested by the EU to develop cross-border EN standards and specifications. It operates alongside the

European Committee for Electrotechnical Standardization (CENELEC) and the European Telecommunications Standards Institute (ETSI) to promote and deliver harmonised standards.

### National Standards

These are the standards, such as British Standards (prefixed ‘BS’), Deutsche Industrie Norms (prefixed ‘DIN’) or Norme Française ‘NF’, that prevail in individual countries. Increasingly, they are being superseded by their European equivalents, in which case they are referred to

as ‘BS-EN’ or ‘BS-EN’ etc.). Similarly, a standard bearing the prefix ‘BS-EN-ISO’ refers to a standard containing the same core information in all cases and which has been adopted across all three territorial boundaries - a truly international standard.

### Proprietary Standards

As we have seen, and despite their limitations, legislated standards are a powerful means of ensuring wholesale compliance with minimum levels of safety, quality and uniformity. However, commercially astute, customer-focused businesses will always endeavour to aspire to

technical specifications, ethical behaviour and levels of customer support that are far in excess of any legal minima. In this way they can differentiate themselves from the ‘only-just-good-enough’ suppliers and demonstrate their superiority.

### Notes

For Information relating to EU ATEX directives (potentially explosive atmospheres) please see Appendix 7. For a summary of the European standards for protective clothing refer to Appendix 7 from British Standards1.

# CE markings, European standards

## and legislative framework

### 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.

### 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.

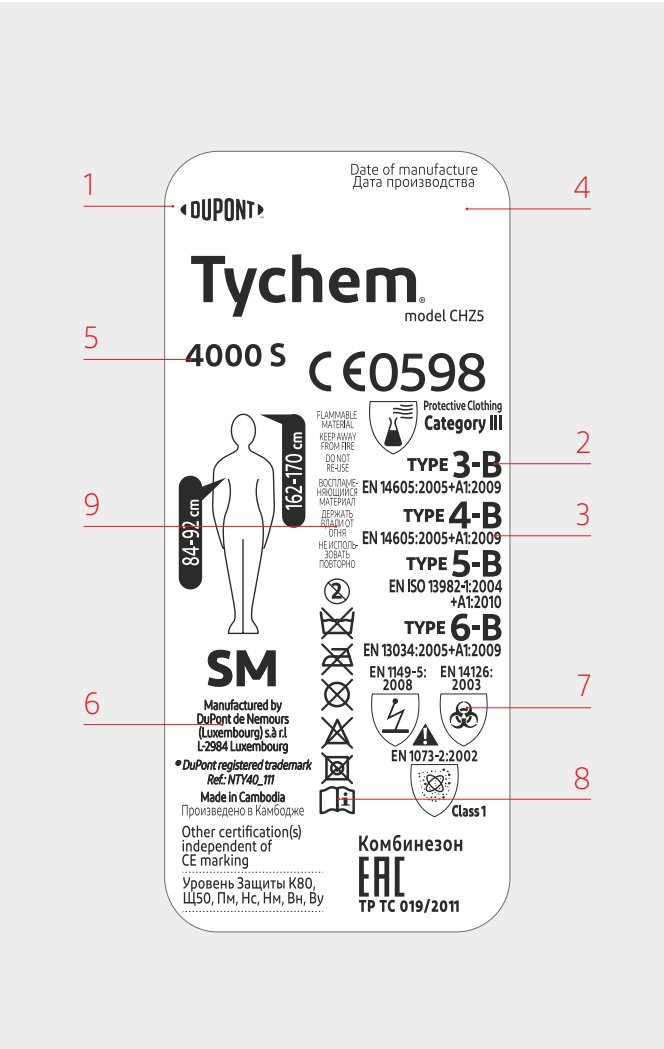
### Marking/labelling attached to garment

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).

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.

The manufacturer is under obligationto have a Quality Control in place to ensure a regular monitoring of the fabric and garment performance vs the basic health and safety requirements of the Directive / upcoming Regulation.



Protective garments – categories, types and classes

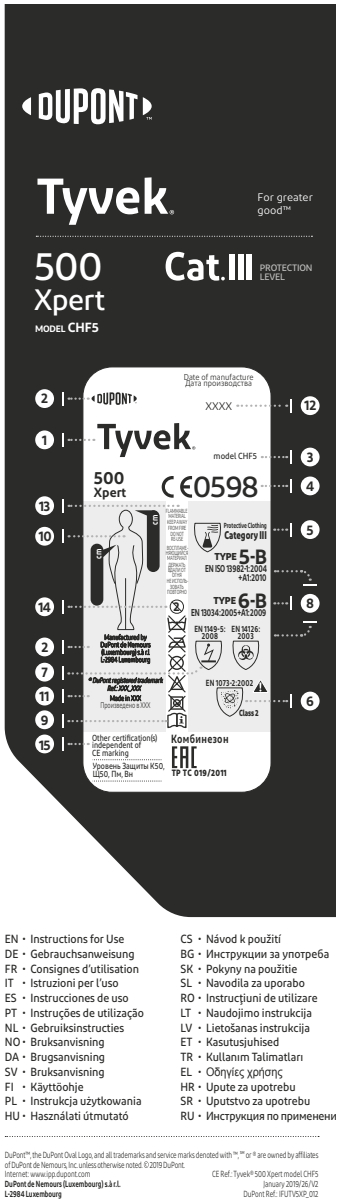
Instructions for Use - information supplied by the manufacturer

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

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

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

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



Protective garments – categories, types and classes

In accordance with PPE Regulation (EU) 2016/425, it is an employer’s responsibility to lay down minimum requirements for the assessment, selection and correct use of personal protective equipment. Priority must be

given to collective safety measures.The following table provides you with a rule of thumb of how to assess risk in the garment selection process:

Table 1 Risk assessment determines required garment performance.

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

The relationship between Garment categories, Types ans Classes

Garment ‘Categories’

PPE Regulation (EU) 2016/425 refer to three “Categories of PPE”. These Categories are shown in the figure and demonstrate that the manufacturer of the product concerned has complied with the relevant performance requirements. In terms of protection, these categories relate to the protective properties of the entire garment where Category I offers the least protection and Category III relates to the highest protection. With Category III garments, in addition to the basic CE certification (according to Module B - Annex V of the PPE Regulation,

the manufacturer must ensure the product continues to conform and meet the the declared performance EN Classes shown in the Instructions for use. Unlike Category I and II PPE, Category III PPE is subject to an annual audit by a Notified Body, which certifies continued conformity and issues a “Quality Surveillance Certificate” as per Module C2/D - Annex VII/VII of the PPE Regulation. Note that all Category III PPE must be identified with the digit code of the notified body appended to the CE mark.

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

PPE Category (Regulation (EU) 2016/425)	Definition	Logo	Initial EC-Type Certification from a notified body (Module B - Annex V**)	Manufacturer’s declaration of Conformity (Annex IX**)	Annual Quality Surveillance Certification by a notified body (Module C2/D - Annex VII/VIII**)
Category III (PPE of complex design)	Includes exclusively risks that may cause very serious consequences such as death or irreversible damage to health	CE XXXX *	Mandatory	Yes	Yes
Category II (neither simple nor complex PPE)	Protection against moderate risk where the product is tested for one value e.g. water resistant gloves or reflective tape for garments.	CE 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

1 OSHA online, Council Directive 89/656/EEC on the minimum health and safety requirements for the use by workers of personal protective equipment at the workplace  
2 European Commision online, Council Directive 89/686/EE on Personal Protective Equipment, (http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX.01989L0686-20130101&from=EN 2013).

\* Garment Type is linked to fabric barrier properties. \*\* Represents the 4 digit numeric code of the notified body.










Protective garments – categories, types and classes

Garment Types

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

When selecting or specifying a Category III garment it is often referred to by its CE 'Type' certification. However this is not sufficient for an appropriate garment selection. Different protective garments that all meet the standards do not necessarily offer the same protection performance (please see Appendix 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.

<div><div></div><div>Chemical Protective Clothing, Category III</div></div>		
Type and Pictogram*	Definition and Exposure Level	Product Standard and Year of publication
<div> TYPE 1 TYPE 1 - ET</div>	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 943-1:2019** EN 943-2:2019
<div> TYPE 2</div>	Non-Gas-Tight Protective clothing against liquid and gaseous chemicals, including liquid aerosols and solid particles.	EN 943-1:2019**
<div> TYPE 3</div>	Liquid Tight Protective clothing against liquid chemicals. Exposure to pressurised jet of liquid.	EN 14605:2005/A1:2009
<div> TYPE 4</div>	Spray Tight Protective clothing against liquid chemicals. Exposure to a liquid spray aerosol (unpressurised).	EN 14605:2005/A1:2009
<div> TYPE 5</div>	Solid Particulates Protective clothing against solid-airborne particulates.	EN ISO 13982-1:2004/A1:2010
<div> TYPE 6</div>	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.

Protective garments – categories, types and classes

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*
<div> **</div>	Protective Clothing with Electrostatic properties – material performance and design requirements.	EN 1149-5:2018
<div> ***</div>	Protective clothing against radioactive contamination.	EN 1073-2 :2002
<div></div>	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
<div></div>	Protective clothing (fabrics) against infective agents (indicate by a 'B' e.g. Type 3-B) and comprising several fabric protection test methods.	EN 14126:2003

Notes

For information on radioactive particulate protection please see Appendix 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 Appendix 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.

\* 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.

Protective garments – categories, types and classes

Table 5 Mechanical performance tests.

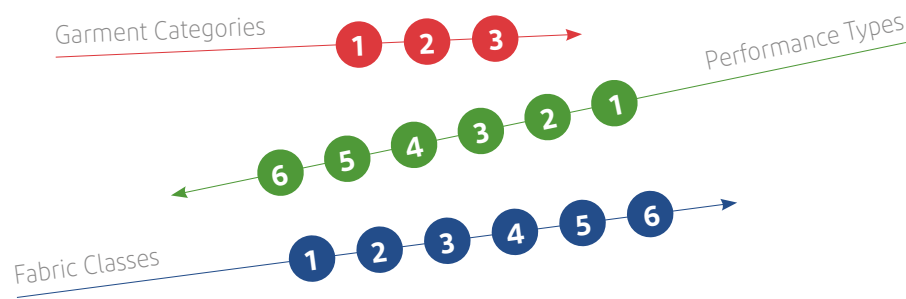
	Test method	Norm	Scope/Principle
Durability	Abrasion resistance	EN 530 Method 2	Abrasion is the physical destruction of fibers, yarns, fabrics resulting from the rubbing of the fabric suface over an abrasive glass paper. It ultimately affects the appearance of the fabric and results in the loss of performance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

A word of caution

It can be seen that there is a degree of inconsistency between the three classifications in that both the garment EN Categories and the fabric Classes use a rating scale where Level 1 represents the lowest level of protection and the highest number represents the highest level of protection. Paradoxically, however, the

garment Type scale works the other way round with a Type 1 classification, i.e. the lowest number, referring to the highest level of protection! This anomaly can be very confusing to the specifier or user and it can be helpful to use some form of mnemonic or visual Aid Memoire to avoid mistakes.

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



Fabrics - types and properties

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

Differents fabric properties

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

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

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

Informational properties		
Basis weight	EN ISO 536	g/m²
Thickness	EN ISO 534	µm
Resistance to water penetration	EN 20811	cm H <sub>2</sub> O
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



# Fabrics - types and properties

## 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)

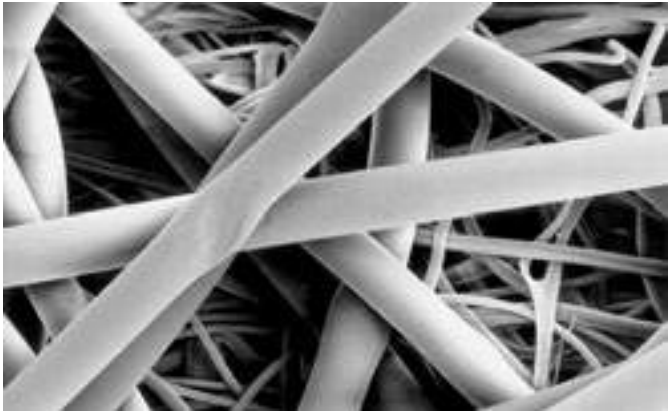
MPF fabrics are a bi-laminate material comprising a thin microporous film bonded to a spunbound polypropylene base. These fabrics offer limited durability since all barrier protection is lost when the protective film layer is abraded. In addition, their low air-permeability characteristics make them 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 spunbound polypropylene layers. This inner polypropylene layer functions as the main filter for particles. However SMS fabrics tend to suffer from limited durability and relatively weak barrier performance due to their relatively open fibre structure. In addition, their high air permeability characteristics significantly compromise the barrier properties of the fabric making it only really appropriate for very basic protection and as a dirt barrier.



1:500 Source: DuPont.

# Fabrics - types and properties

## 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.

After 10 Cycles of abrasion

## SMS



## MICROPOROUS FILM (MPF)



## DuPont™ TYVEK®



Figure 1 Abrasion: Simulation of wear and tear in everyday use, Source: DuPont

Fabric testing

Mandatory Tests

A CE marking signifies that chemical protective clothing meets certain minimum requirements (please see Appendix 1). However, it does not mean that chemical suits of the same Type offer the same level of protection performance. This is why it is essential to look at the results of the tests carried out on the material used to make the garment. As part of the CE requirements a number of mandatory fabric tests are required and, for each Type, these are classified from Class 1 (lowest) to Class 6 (highest). For further information *please see Appendix 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 fabric suface over an abrasive glass paper. It ultimately affects the appearance of the fabric and results in the loss of performance properties after a number of cycles.
	Flex cracking resistance	EN ISO 7854 Method B	Flex cracking simulates repeated flex and folds in the fabric. The number of cycles to failure indicated by cracks and holes is recorded.
	Tear resistance	EN ISO 9073-3	Tear resistance determines the trapezoid tear resistance of a nonwovens by applying a continuously increasing extension in such a way that a tear propagates across the width.
	Tensile strength	EN ISO 13934-1	Tensile strength determines the maximum force and elongation at maximum force of the fabric using a strip method. The fabric is extended at a constant rate until it ruptures.
	Puncture resistance	EN 863	Puncture records the maximum force required to push a spike through the fabric with a constant rate until it perforates.
	Seam strength	EN ISO 13935-2	Seam strength determines the maximum force of seams when the force is applied perpendicularly to the seam which is extended until it ruptures.

Fabric testing

Penetration vs Permeation

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

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

Notes:

Fabrics used in garments certified to Type 6 are typicallyonly tested for liquid penetration and repellency. This is why the scope of type 6 garments is intended for applications with “potential exposure to small quantities of fine spray/mist or accidental low volume splashes and where wearers are able to take timely adequate action in case of contamination”. Therefore, it is preferable to

verify the permeation data of the fabric even for Type 6 garments. Permeation and Penetration should not be confused. Many ‘microporous’ fabrics which can offer good liquid repellency characteristics, i.e. low penetration properties, exhibit high permeation rates which means liquids, in practice, will quickly permeate through.

Table 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.



Fabric testing

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.

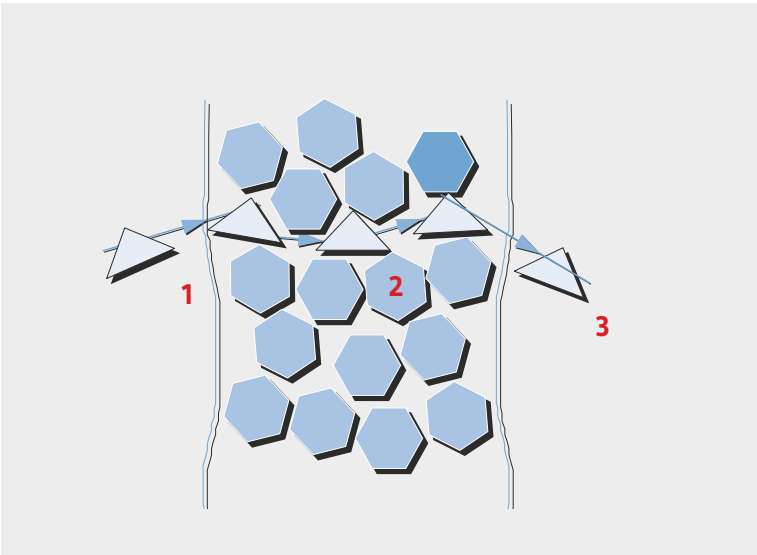


Figure 3 Permeation, Source: DuPont

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.

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 (cm²) 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/cm²/min in certain cases.

Fabric testing

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 143251 – is based upon the normalised breakthrough time measured according to EN ISO 65292 at 1.0 µg/cm2/min. Normalised breakthrough time is the average elapsed time between initial contact of the substance with the outer surface of the protective clothing material and the time at which the substance is detected at the inside surface at a defined permeation rate. The breakthrough time is ‘normalised’ as it is independent of the sensitivity of the measuring device. A normalised breakthrough time of >8 hours means that the average permeation rate has never reached the rate defined according to EN ISO 6529 (0.1 µg/cm²/min or 1.0 µg/cm²/min). However, the substance may have actually broken through.

Actual breakthrough

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

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

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 wear time 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, joints and assemblages.  
\*2 EN ISO 6529:2013 - Protective clothing. Protection against chemicals. Determination of resistance of protective clothing materials to permeation by liquids and gases.  
\* EN 14325: Protective clothing against chemicals – test methods and performance classification of chemical protective clothing.

# Fabric testing

## Liquid penetration and repellency test

The liquid penetration and repellency test is performed according to EN ISO 65301 (superseding EN 368) and is often referred to as the 'Gutter Test'.

### Schematic of the test apparatus

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

### Penetration index

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

### Repellency index

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

## Cemical 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

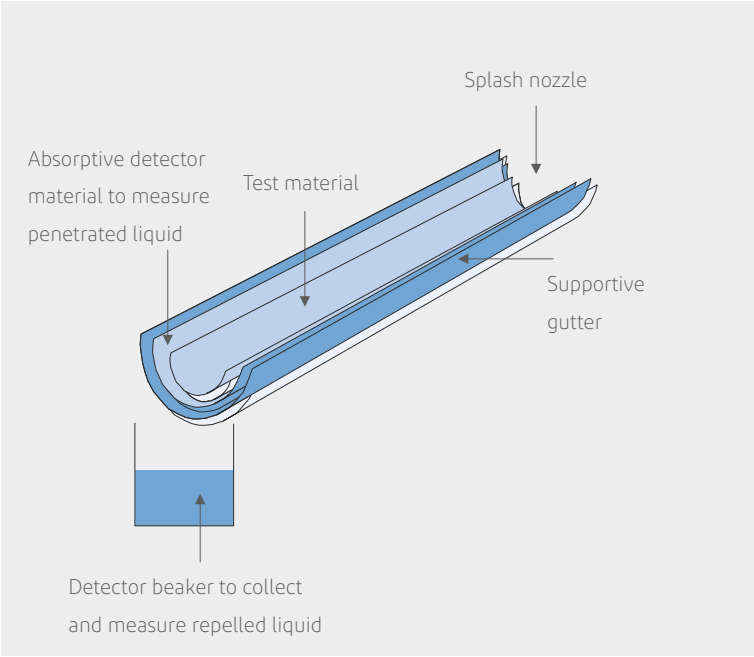


Figure 5 Gutter Test, Source: DuPont

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.

hazardous chemicals is required, we recommend you contact the manufacturer for expert advice.

# Fabric testing

## 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 Appendix 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.

### 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.

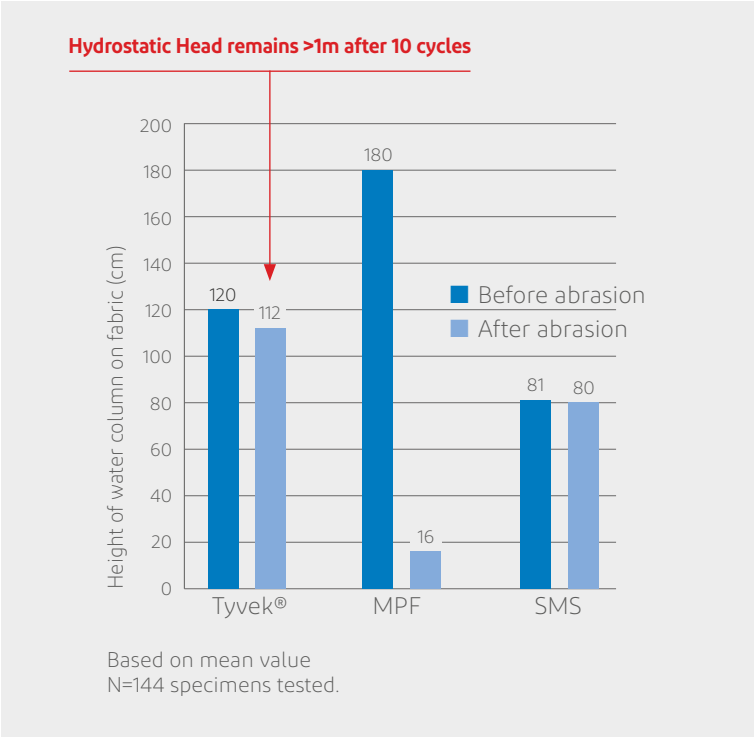


Figure 6 Liquid barrier performance. Hydrostatic Head: EN 20811. Before and after 10 cycles of abrasion (EN 530 - Method 2), Source: Independent Institute

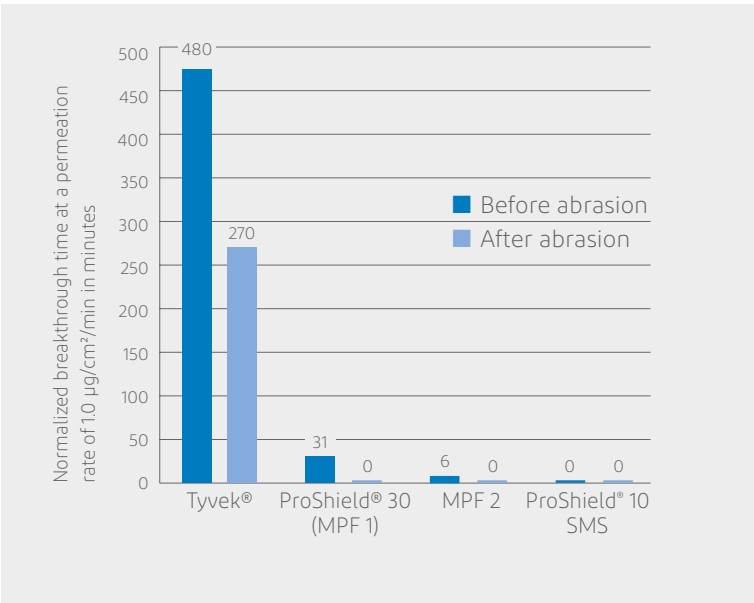


Figure 7 Permeation resistance to sulfuric acid 18%, Source: Independent Institute



## Fabric testing

## 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 aureus) 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 aureus) 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 943-1:2019, EN 943-2:2019
2-B	Non gas-tight	EN 943-1:2019, EN 943-2:2019
3-B	Protection against pressurised liquid chemicals	EN 14605:2005 +A1:2009
4-B	Protection against liquid aerosols (spray tight)	EN 14605:2005 +A1:2009
5-B	Protection against airborne solid particulates	EN ISO 13982-1:2004 +A1:2010
6-B	Limited protection against liquid chemicals (light spray)	EN 13034:2005 +A1:2009

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

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

## 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 /PPE Regulation (EU) 2016/425 and in the case of a Category III suit will include the registration number of the Notified Body, in the form 'CE- - -', that certifies ongoing fulfilment.

## Type Testing

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

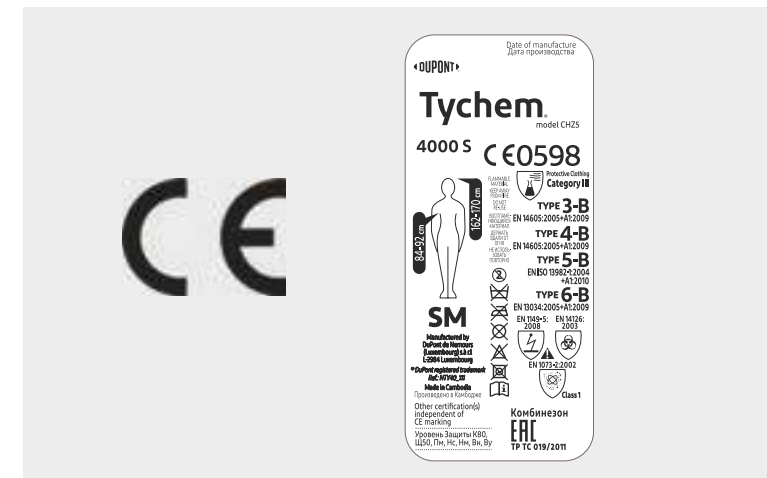
## A word of caution

The EN whole-suit Type-tests (*please see Appendix 3*) define a maximum allowable amount of challenge test liquids, aerosols or particulates to ingress into the suit.

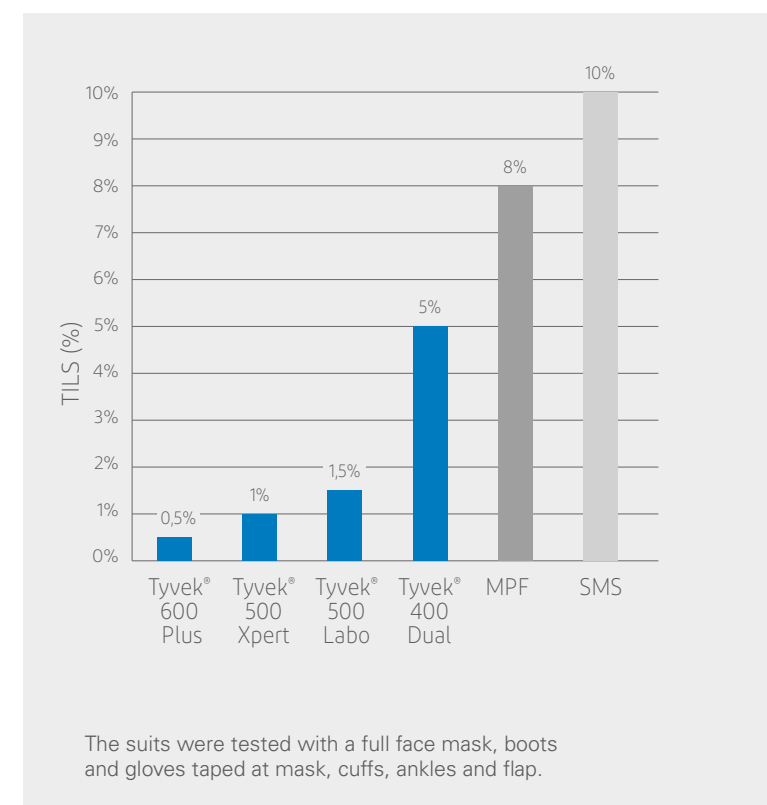
### Example

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, penetrations/spots at a maximum of 3 cm<sup>2</sup> 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.



'Type' of protection, a fabric's physical and barrier properties must also meet minimum performance requirements (*please see Appendix 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.



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

# Whole garment performance

## Whole-suit Type Tests

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

## Whole-suit Type Tests

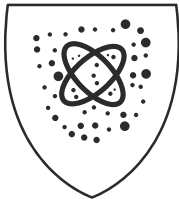
Radioactive particulate matter is dust and very fine particles which have been exposed to ionising nuclear radiation. Unless contained and managed these contaminated particulates not only present a serious health hazard to any personnel in proximity but, without proper safeguards, there is a further 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 inwardleakage 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 evaluatingthe 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.



# Whole garment performance

## Seam contruction 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 configurationsand connection systems are available which provide the necessary strength and impenetrability for different hazard and usage situations. The same considerations apply to closure systems such as zips and storm flaps, and to garment interfaces and boundaries in the neck, hood, wrist and ankle areas.

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

Type 3/4



### Stitched & Overtapes seams

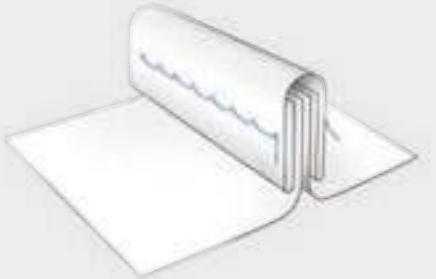
Seams can be stitched and overtaped. The tapes used for DuPont products with this type of seam offer a barrier equal to that of the fabrics.

Type 5/6



### Stitched seams

Stitching offers good balance between seam strength and seam barrier.



### Bound seams

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

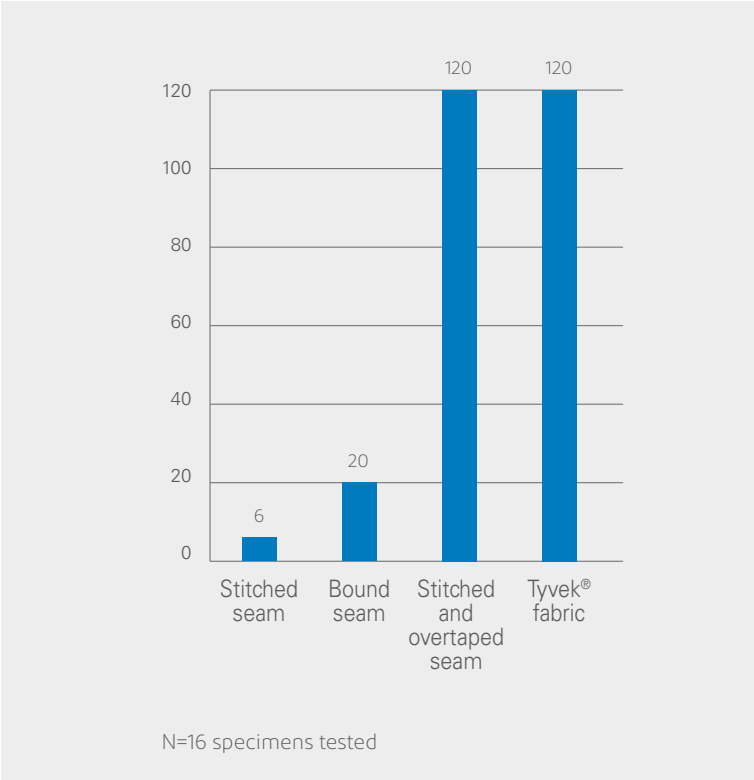
Figure 9 Three types of seam construction, Source: DuPont



# Whole garment performance

## Pressurised exposure resistance

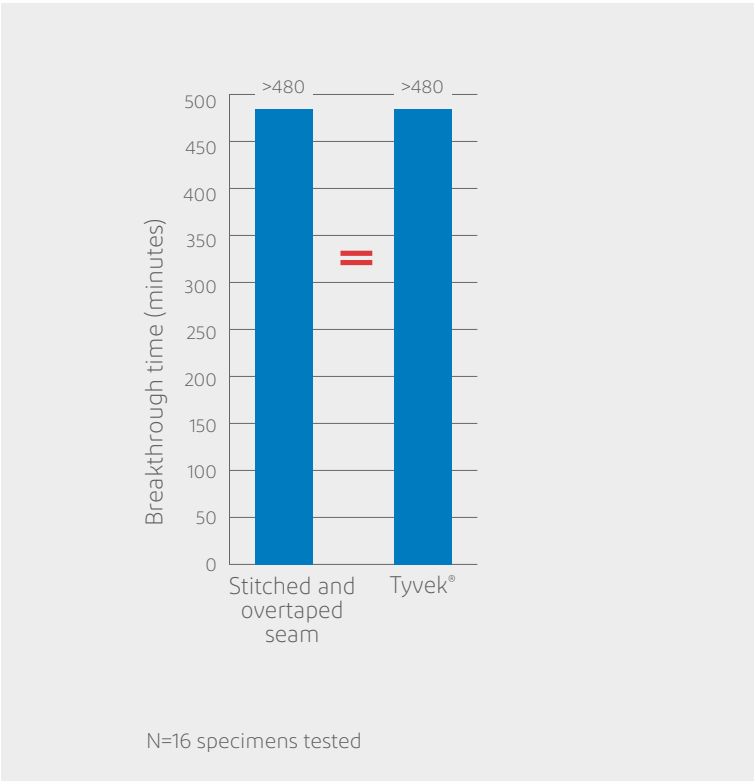
Hydrohead is an indicator for pressurised exposure resistance. The test is based on water column test, stichted and overtaped seams are tight and offer the same barrier as the fabric itself.



**Figure 10** Pressurized exposure resistance. Hydrohead DIN EN 20811 (centimeters of H2O), Source: DuPont

## Permeation results

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



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

# Comfort considerations

## Key comfort factors

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

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

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

## The need for comfort

When it comes to day-in day-out health and safety compliance, operator comfort is one of the key ‘human factors’ that govern the correct use of personal protective equipment (PPE). The importance of wear comfort and correct garment fitting cannot be overstated. A large proportion of observed PPE non-compliance

occurrences are not due to an absence of protection but are simply due to workers avoiding, misusing or abusing the protection provided. And even where staff are wearing the appropriate equipment, if it doesn’t fit or if it isn’t comfortable then it is often being worn incorrectly<sup>1</sup>.

## 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.

# Comfort considerations

## 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

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.

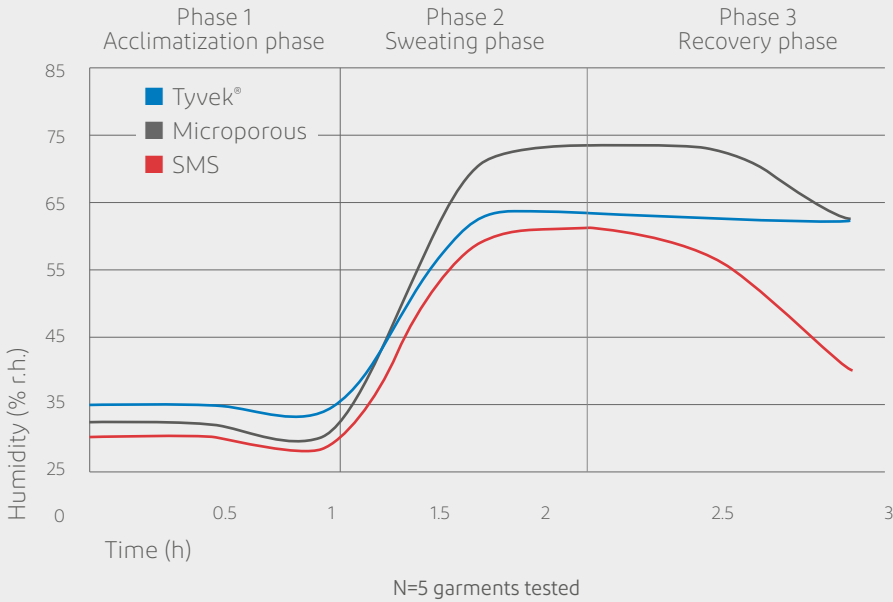


Figure 12 Humidity between underwear and garment (by family)  
Source: Independent Institute

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

Source: Directive 99/92/EC

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.



# Static electricity discharge

## 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.

## 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

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.

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 ATEX1 Directives to protect employees from explosion risk in areas with an explosive atmosphere.

There are two ATEX directives:

- The new ATEX Directive 2014/34/EU2 is for equipment manufacturers and covers equipment and protective systems intended for use in potentially explosive atmosphere.
- The 'ATEX 137' workplace directive 99/92/EC3 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 1149-5:20184 which provides the performance requirements for anti-static PPE.

## Notes

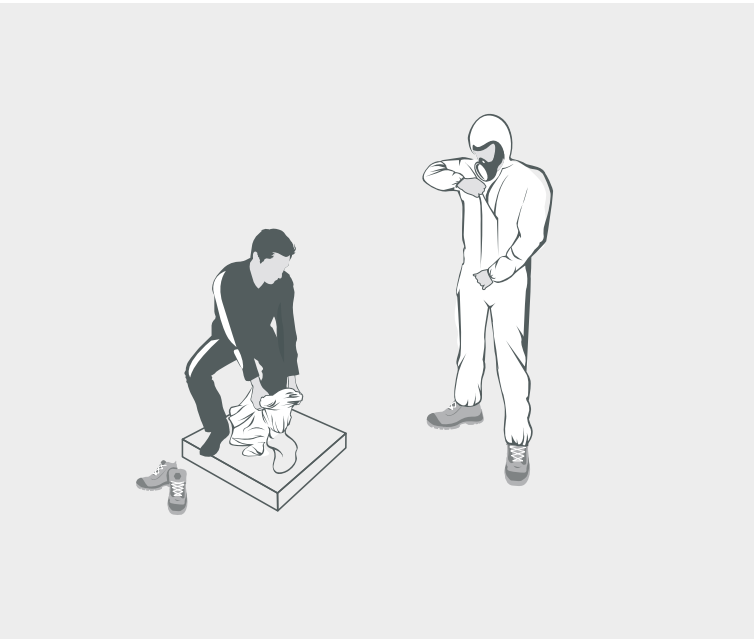
For the antistatic performance data relating to a particular product please refer to the relevant technical data.

# 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.

# 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

## 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

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.

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® 2000 C	10
Tychem® 6000 F	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.

# 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 14001. DuPont is comitted to the efficient utilisation of reutilisation of resources and collaborates with designers, converters, manufacturers and others to help them meet their sustainability goals.

### Most preferred option

1

Virgin, unpigmented Tyvek® can be 100% recycled back into equivalent quality product with no loss of properties or functionality whatsoever. DuPont has been carrying out this recycling process at its manufacturing plants for several decades.

2

Using the right preparatory and processing equipment, used but uncontaminated Tyvek® can also be recycled at facilities accepting grade 2 HDPE. Reclaimed material can be repurposed into new quality products such as garden furniture, milk crates, wall cladding, toys, refuse containers and waste pipes.

3

Subject to local regulations, contaminated Tyvek® can be safely incinerated and, under optimal conditions, will only release water and carbon dioxide, leaving no significant residues. It can be used a fuel yielding more than twice the energy value of coal, and as much energy as oil, in terms of BTU rating.

4

If recycling or incineration are not options, Tyvek® can be safely landfilled. Because it is chemically inert and contains no fillers, binders or additives, Tyvek® will not leach into groundwater nor release contaminants into the soil.

### Least preferred option

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

### 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.





**DuPont™ SafeSPEC™ - We're here to help**



Our powerful web-based tool can assist you with finding the appropriate DuPont garment for chemical or cleanroom environment.  
**[safespec.dupont.asia](https://safespec.dupont.asia)**



**DuPont Personal Protection**

Malaysia Tel: (603)2859 0700  
Singapore Tel: (65) 6586 3067  
Thailand Tel: (662) 659 4000  
Indonesia Tel: (6221)782 2555  
Vietnam Tel: (84) 28 3866 8079



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. This information is not intended as a license to operate under or a recommendation to infringe any patent or technical information of DuPont or other persons covering any material or its use.