Product Catalogue

DuPont Personal Protection

DUPONT Kevlar | Nomex | Tyvek | Tychem

DuPont Personal Protection
CONTENT OVERVIEW

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™ | DuPont™ SafeSPEC™

DuPont Product Range

Tyvek®

Superior protection against particulates and water-based chemical splashes	**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® 400 Dual	Protection and durability in the front breathability in the back	Cat.III, Type 5, 6, EN 1073-2, EN 1149-5
	Tyvek® 500 HV	All-in-one solution: high-visibility (to the highest class), chemical, biological and antistatic protection in one coverall	Cat.III, Type 5-B, 6-B, EN 14126, EN 1073-2, EN 1149-5, EN ISO 20471, RIS-3279-TOM Issue 1 (replaces GO/RT 3279 Issue 8)
	Tyvek® 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

Tychem®

Concentrated inorganic chemicals	**Tychem® 2000 C**	Comfortable, lightweight protection against biohazards and inorganic chemicals	Cat.III, Type 3-B, 4-B, 5-B, 6-B,EN 14126 EN 1073-2, EN 1149-5
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 Plus**	Tychem® 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

DuPont Product Range

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

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
T1	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
T2	TYPE 2	Non-Gas-Tight Protective clothing against liquid and gaseous chemicals, including liquid aerosols and solid particles.	EN 943-1:2019**
T3	TYPE 3	Liquid Tight Protective clothing against liquid chemicals. Exposure to pressurised jet of liquid.	EN 14605:2005/A1:2009
T4	TYPE 4	Spray Tight Protective clothing against liquid chemicals. Exposure to a liquid spray aerosol (unpressurised).	EN 14605:2005/A1:2009
T5	TYPE 5	Solid Particulates Protective clothing against solid-airborne particulates.	EN ISO 13982-1:2004/A1:2010
T6	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.

Australian Toll-Free: **1800 789 308**
New Zealand Toll-Free: **0800 555 799**

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!

YouTube

www.safespec.dupont.co.uk

DUPONT™ | DuPont™ SafeSPEC™

Garments & Accessories

Tyvek®

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	DuPont Code: Size Orange
D14663953: SM	D13675136: MD
D14663967: MD	D13675140: LG
D14663977: LG	D13675152: XL
D14663986: XL	D13675167: 2X
D14663997: 2X	D13675175: 3X
D14664003: 3X	Carton Qty - 50EA
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

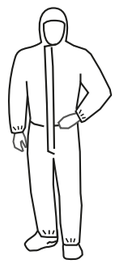
Maintenance operations

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 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	D15522181: MD D15522182: LG D15522183: XL D15522184: 2X D15522185: 3X Carton Qty - 25EA

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

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.

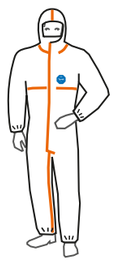
Liquid protection and/or oil repellency | **Petrochemical installations** | **Maintenance operations**

Waste handling | **Chemical processing**

Self-adhesive chin flap

Elasticated waist

Thumb loops



DuPont Code: Size	D15441661: MD D15441676: LG D15441684: XL D15441698: 2X D15441708: 3X Carton Qty - 25EA

* Does not protect against ionizing radiation.

Tyvek® 500 Accessories

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

	**Tyvek® 500 Labcoat with press studs and pockets** Labcoat with collar, available in white and in sizes MD to 2XL. 5 press stud closures. 3 pockets. Stitched internal seams. **CE Category & Type:** Cat. III - Type PB[6]*	D13396079 -MD D13396069 - LG D13396050 - XL D13396040 - 2X Carton Qty - 50EA
	**Tyvek® 500 Labcoat with press studs** Labcoat with collar, available in white and in sizes MD to 2XL. 5 press stud closures. Without pockets. Elasticated cuffs (not tunnelled). Stitched internal seams. **CE Category & Type:** Cat. III - Type PB[6]*	D13495990 - MD D13398884 - LG D13398975 - XL D13495953 - 2X Carton Qty - 50EA
	**Tyvek® 500 Labcoat with zipper and pocket** Labcoat with collar, available in white and in sizes SM to 2XL. Zipper closure. 2 pockets. Elasticated cuffs (tunnelled). Stitched internal seams. **CE Category & Type:** Cat. III - Type PB[6]*	D13496004 - SM D13495983 -MD D13398951 - LG D13398984 - XL D13495948 - 2X Carton Qty - 50EA
	**Tyvek® 500 Apron** Shin-length apron with neck and waist ties. Available in white and in one size (length 108 cm). **CE Category & Type:** Cat. III - Type PB[6]*	D13396088 - One Size Carton Qty - 100EA
	**Tyvek® 500 Jacket** Hooded jacket available in white and in sizes MD to 2XL. Zipper closure. Stitched internal seams. **CE Category & Type:** Cat. III - Type PB[6]*	D13496063 - MD D13496057 - LG D13396450 - XL D13496041 - 2X Carton Qty - 50EA
	**Tyvek® 500 Trousers** Trousers available in white and in sizes MD to 2XL. Without pockets. Elasticated waist, no elastic at ankles. Stitched internal seams. **CE Category & Type:** Cat. III - Type PB[6]*	D13496109 - MD D13395741 -LG D13395735 - XL D13496097 -2X Carton Qty - 50EA

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

Tyvek® 500 Accessories

	**Tyvek® 500 Hood** Hood with flange and elasticated face and neck. Available in white and in one size. **CE Category & Type:** Cat. III - Type PB[6]*	D13395804: One Size Carton Qty - 100EA
	**Tyvek® 500 Sleeve** 50 cm long sleeve available in white and in one size. Adjustable arm opening. Stitched internal seams. Upper-arm in blue-coloured thread for identification purposes. **CE Category & Type:** Cat. III - Type PB[6]*	D13398912: One Size Carton Qty - 200EA
	**Tyvek® 500 Boot cover** Knee-length overboot available in white and in one size. Elasticated top and fixation ties. Stitched internal seams. **CE Category & Type:** Cat. III - Type PB[6]*	D13395724 - One Size. Carton Qty - 200EA Made to Order
	**Tyvek® 500 Boot cover with antislip** Knee-length overboot available in white and in one size. Elasticated top and fixation ties. Stitched internal seams. Slip-retardant sole. **CE Category & Type:** Cat. III - Type PB[6]*	D13395989: One Size Carton Qty - 200EA
	**Tyvek® 500 Shoe cover** Shoe cover available in white and in one size (38 cm long). Elasticated ankle. Stitched internal seams. **CE Category & Type:** Cat. III - Type PB[6]*	D13395783: One Size Carton Qty - 400EA
	**Tyvek® 500 Shoe cover with antislip** Shoe cover available in white and in sizes 36 to 42 and 42 to 46. Elasticated ankle. Stitched internal seams. Slip-retardant sole. **CE Category & Type:** Cat. III - Type PB[6]*	D13398565 - (36-42) - MTO D13398551 - (42-46) Carton Qty - 200EA

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

Garments & Accessories

Tychem®

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**

Self-adhesive zipper and chin flap

DuPont Code: Size	D13675305: SM D13675315: MD D13675324: LG D13675336: XL D13675340: 2X D13675352: 3X Carton Qty - 50EA

* Does not protect against ionizing radiation.

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**

Double zipper system

Thumb loops

DuPont Code: Size	D15334570: MD D15334587: LG D15334591: XL D15334603: 2X D15334618: 3X Carton Qty - 20EA

* 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]*

D13984692 - MD D13984725 - 2X
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]*

D13984657: One Size
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]*

D13984632: One Size
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]*

D13984672: One Size
Carton Qty - 50EA

* 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	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 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® 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.

Oil and gas | **Emergency response** | **Petrochemical applications**

Double zipper system

Self-adhesive chin and zipper flap

Thumb loops

DuPont Code: Size	D15344179: MD D15344186: LG D15344191: XL D15344201: 2X D15344210: 3X Carton Qty - 10EA

* Does not protect against ionizing radiation.

Tychem® 6000 F FaceSeal

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

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.

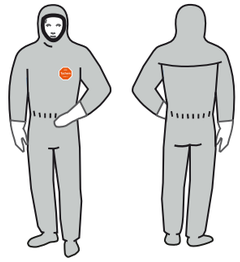
Specially for emergency responder teams who may stock the garments for longer periods of time, the manufacturing date is featured on the box packaging.

Chemical spill clean-up | **Emergency response** | **Petrochemical applications**

Tight fitting hood

Double zipper flap

Attached under gloves



DuPont Code: Size	D15490467:LG D15490481: MD D15490543: XL D15490598: 2X D15490650: 3X Carton Qty - 1EA

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

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]*

D13984758 - MD (MTO) D13984782 - 2X
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]*

DuPont Code: Size
D13984662: One size
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]*

DuPont Code: Size
D13984645: One Size
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]*

D13396376: One Size
Carton Qty - 50EA

* Partial body protection.

Tychem® 6000 FR ThermoPro

Category III | TYPE 3 | TYPE 4 | TYPE 6 | EN 1149-5 | EN ISO 11612 | EN ISO 11611 | IEC 61482-2 | EN ISO 14116 Index 3

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.

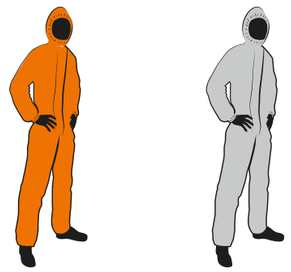
Oil and gas | **Emergency response** | **Chemical industry**

Hood with tight fit to face mask

Flame retardant draw strings

Sleeve cuff with tunneled elastic

DuPont Code: Size Orange:	DuPont Code: Size Grey:
D15123488: MD	D15123341: MD
D15123494: LG	D15123353: LG
D15123502: XL	D15123368: XL
D15123515: 2X	D15123376: 2X
D15123527: 3X	D15123389: 3X
D15123532: 4X	D15123392: 4X
Carton Qty - 2EA	Carton Qty - 2EA



MTO = Made to order.

Tychem® 6000 FR ThermoPro Combo & Apron

Category III | TYPE 3* | TYPE 4* | TYPE 6* | EN 1149-5 | EN ISO 11612 | IEC 61482-2 | EN ISO 14116 Index 3

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

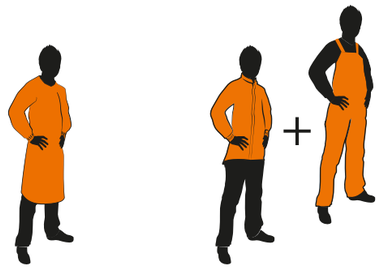
Sleeved gown available in bright orange for high visibility. Adjustable FR buckles at back of waist and shoulder. Integral sleeves with elasticated wrists. Sewn with DuPont™ Nomex® thread Tychem® 6000 FR ThermoPro accessories provide partial body protection (Cat. III PB[3]) and must be used in conjunction 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.

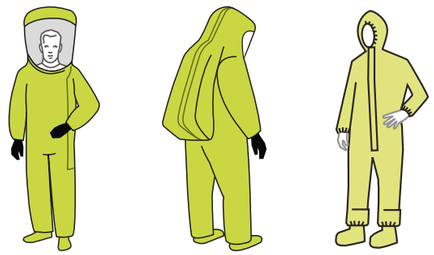
Oil and gas | **Emergency response** | **Chemical industry**

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)



MTO = Made to order

ProShield®

ProShield® 20

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

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.

General maintenance

Industry

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

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

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

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**.

Petrochemical industries

Welding, gas and metal applications

Railway

3 piece hood

Elasticated wrists

Elasticated waist

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

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

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

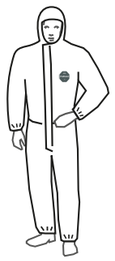
Industry

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.

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.

1964
Kevlar® developed

1969
Apollo II, Kevlar® lands on the moon

1975
PASGT vest and helmet, Kevlar® protects American troops

1987
Ferrari F40, Kevlar® burns rubber in style

2006
New Horizons Space Probe, Kevlar® flies past Pluto

2013
Nike Elite II Series, Kevlar® hits the blacktop, Lebron wins his first championship

2014
Google TransPacific Fiber Cable, Kevlar® protects the internet

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

* NSC.org, 2013 Safety Statistics for the Well Service Industry

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
- Flat yarn
- Staple based spun yarn
- Textured yarn

Engineered yarns
- Fiber blends
- Reinforced with glass, steel

Coating
- PU
- Nitrile
- PVC
- Latex

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

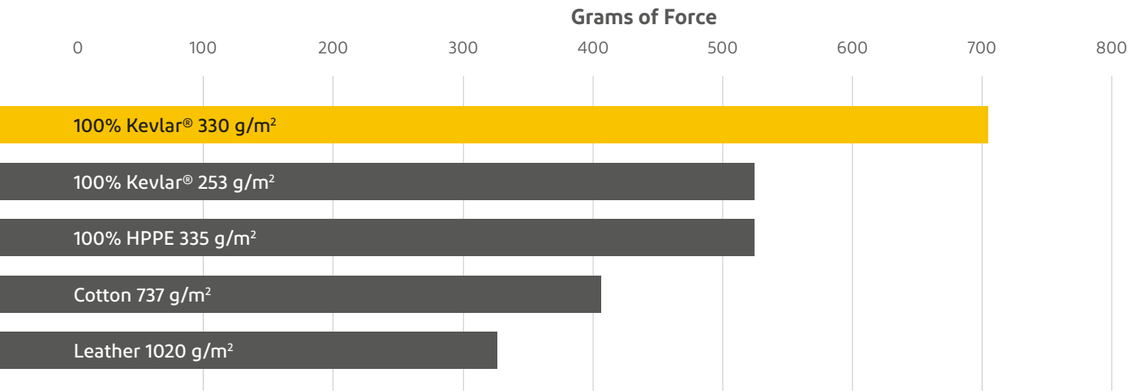
Highly breathable

Flexibility

Dexterity

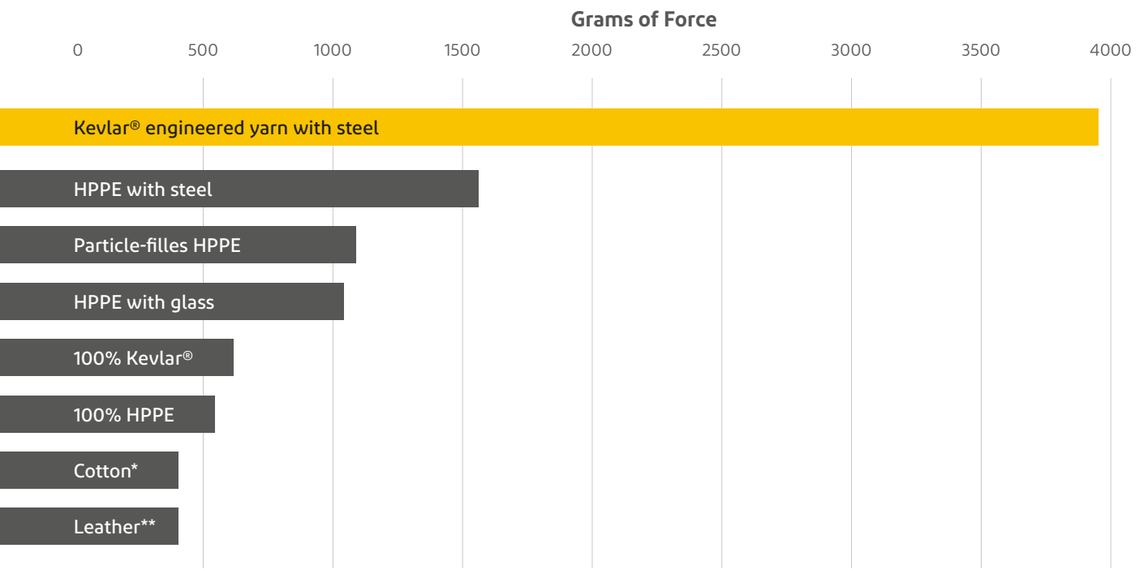
Protection that's a cut above

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

* Cotton 737 g/m² **Leather 1020 g/m²

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

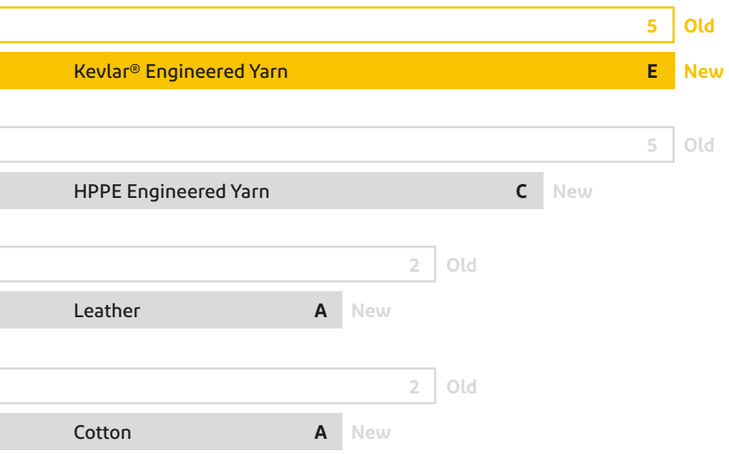
2x higher air permeability
Lightweight, highly breathable and less rigid—giving users the comfort they want.

Kevlar®

Test method: ASTM F737 for air permeability.

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.

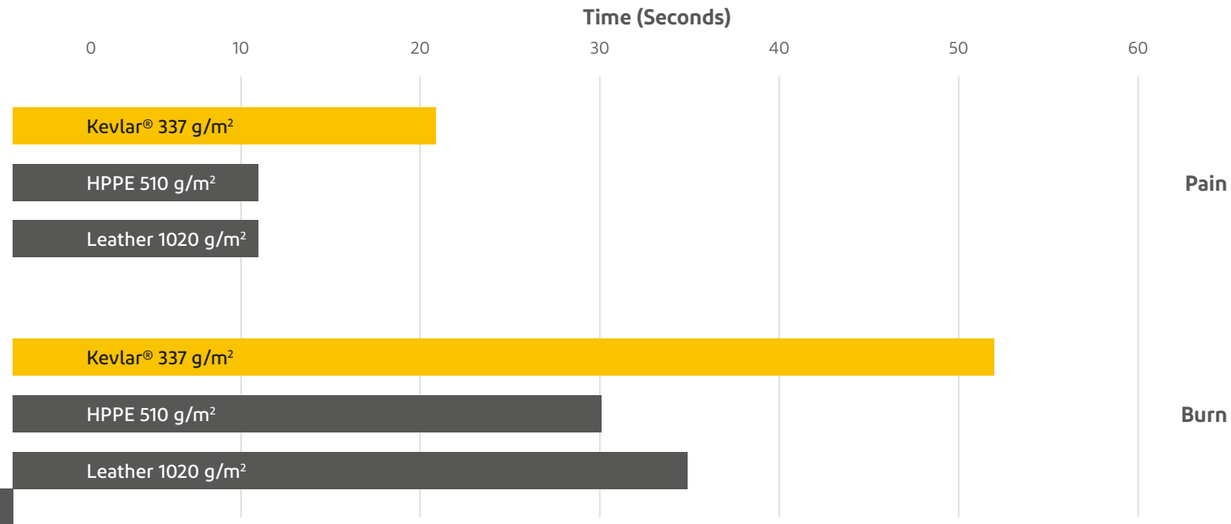
HPPE is not recommended for prolonged use above 70°C and has a melting point of 130°C.

	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.

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).

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.

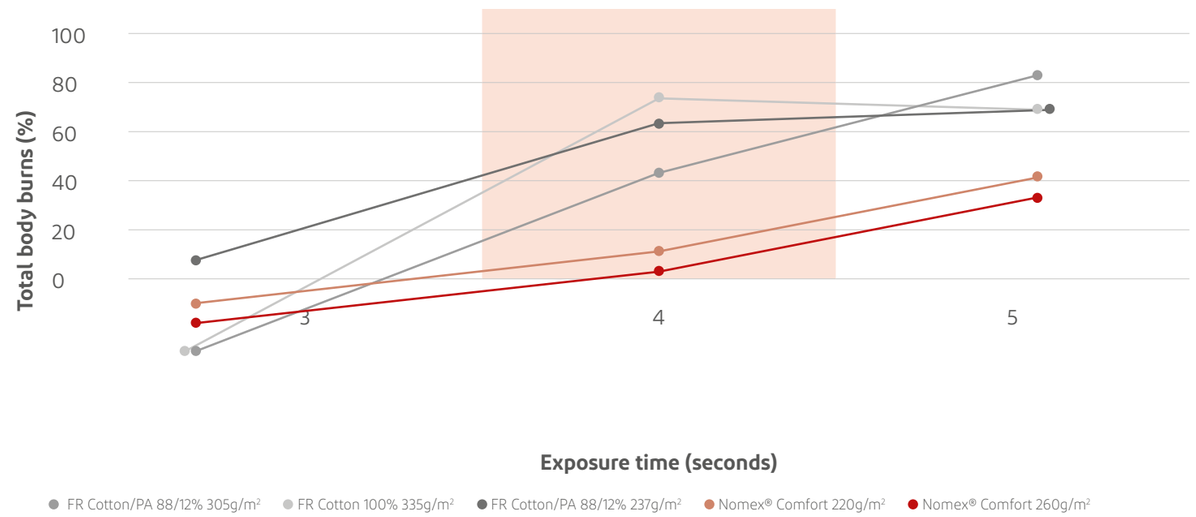
Thermal Protection Performance

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.

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

Nomex® Comfort 220g/m² | Nomex® Comfort 260g/m² | FR Cotton/PA 88/12% 237g/m² | FR Cotton/PA 88/12% 305g/m² | FR Cotton 100% 335g/m²

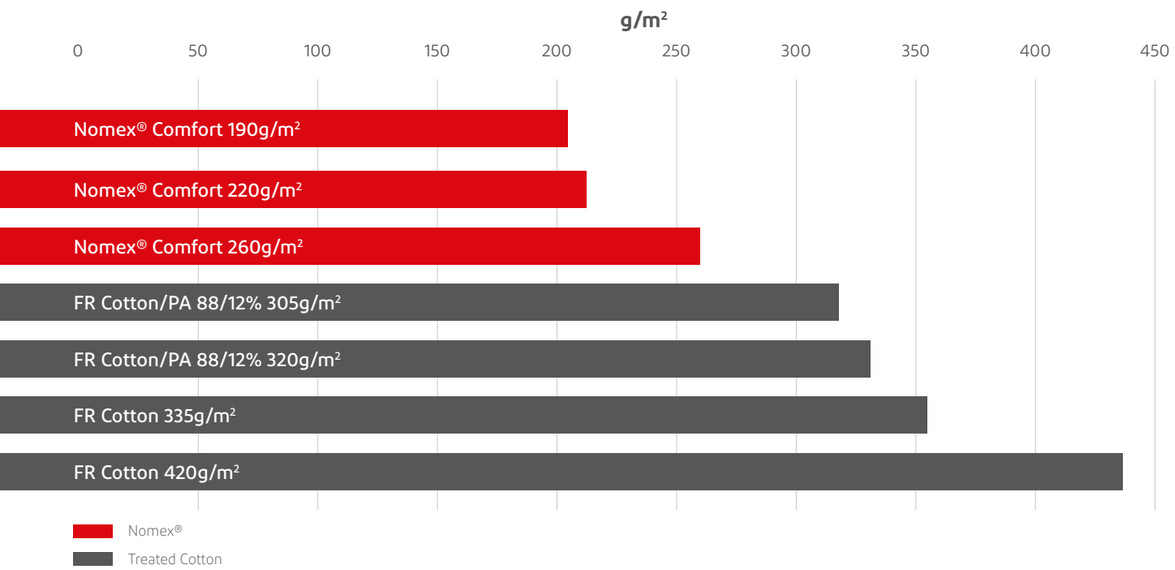
Wearer's Comfort

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



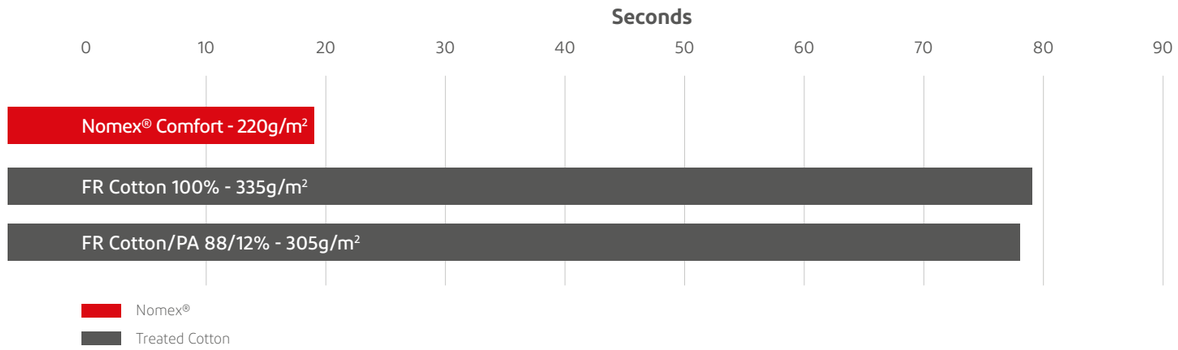
Weighing between 150 and 265g/m², typical Nomex® solutions are up to **40% lighter** than FR cotton and cotton blend fabrics, and therefore **more comfortable** to wear.

Wearer's Comfort

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

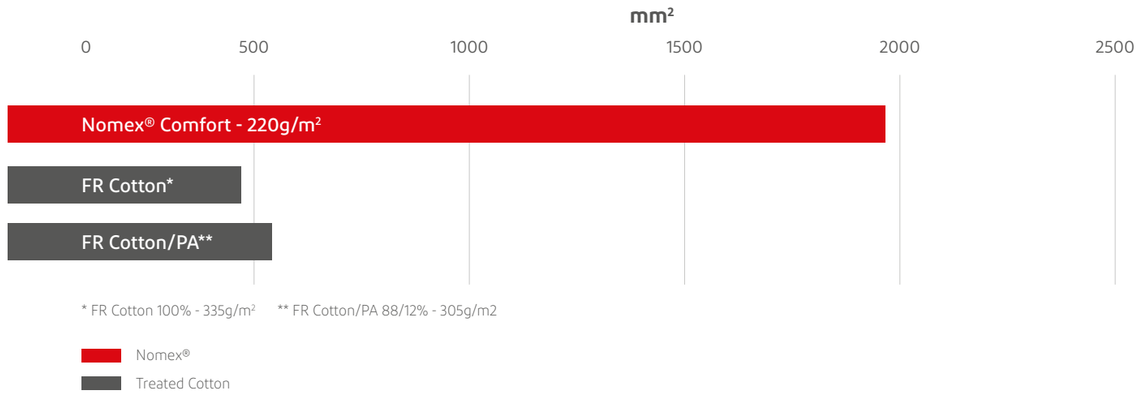
Moisture management

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

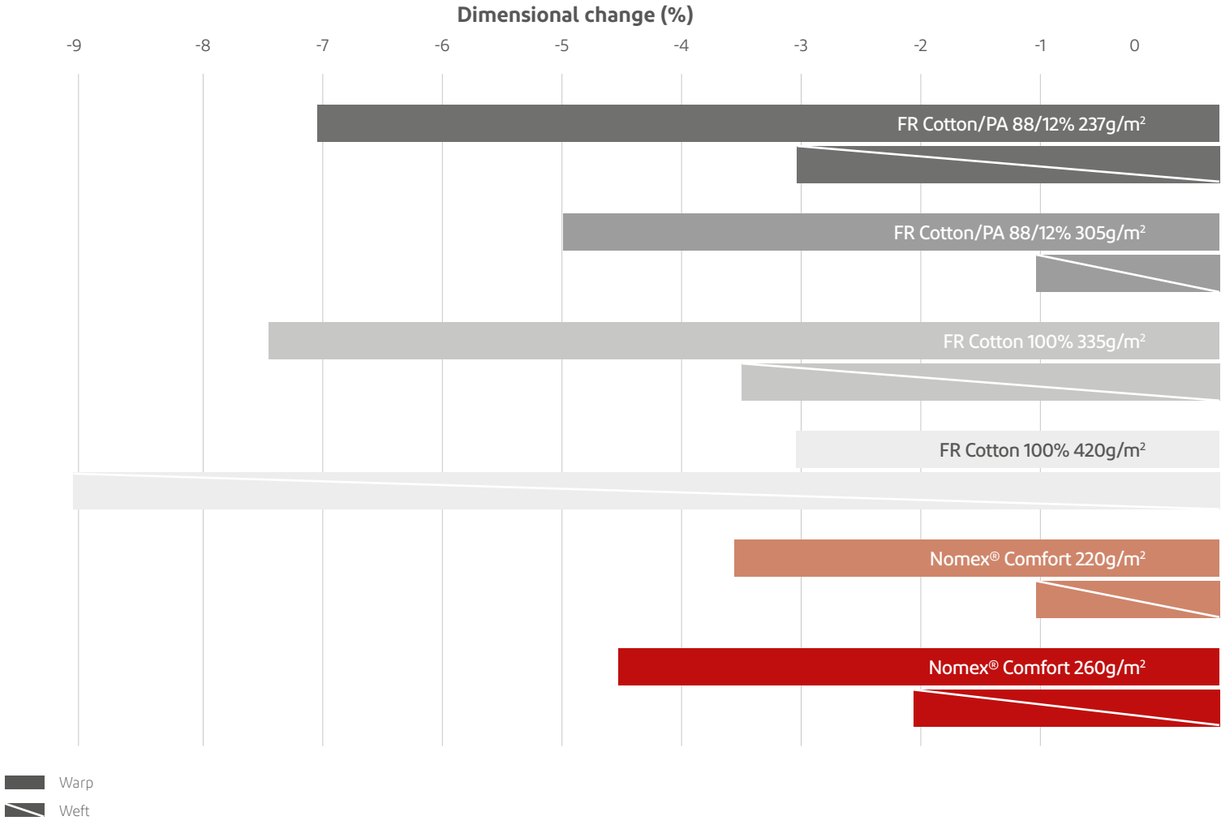
DuPont™ Nomex® is a highly cost-effective solution in terms of cost per wear thanks to its exceptional durability.

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.

DuPont™ Nomex®:

key benefits for protective apparel

DUPONT™
Nomex®

- 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

Warning

Step 4 Determine protective performance requirements of the fabric and seam

Step 5 Determine mechanical performance requirements

Step 6 Comfort considerations

Step 7 Supplier selection

APPROVED

Step 8 Identify the correct usage of the product

Step 9 Wear test

TRY IT!

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:

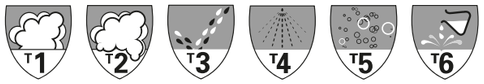
1. Objectively identify the potential hazards including their sources and any associated trigger events. A suitable hazard assessment form or software package might be used for this purpose.
2. Determine those who might be affected by exposure to a hazard and in what circumstances.
3. Evaluate the risks 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

Warning

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.

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

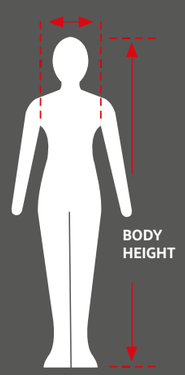
5

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, susceptibilityto tearing, and seam integrity. To assess these qualities it is highly recommended that all garments under consideration are subjected to wear trials under 'actual conditions' of use (please see Step 8).

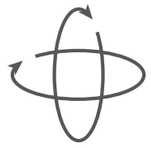
Two important factors that contribute to protection-in-use (and overlap with comfort and ease-of-use considerations are garment sizing and garment fit (please see donning and doffing videos). The correct size and cut of a protective coverall has a huge impact on the protection provided to the wearer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

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

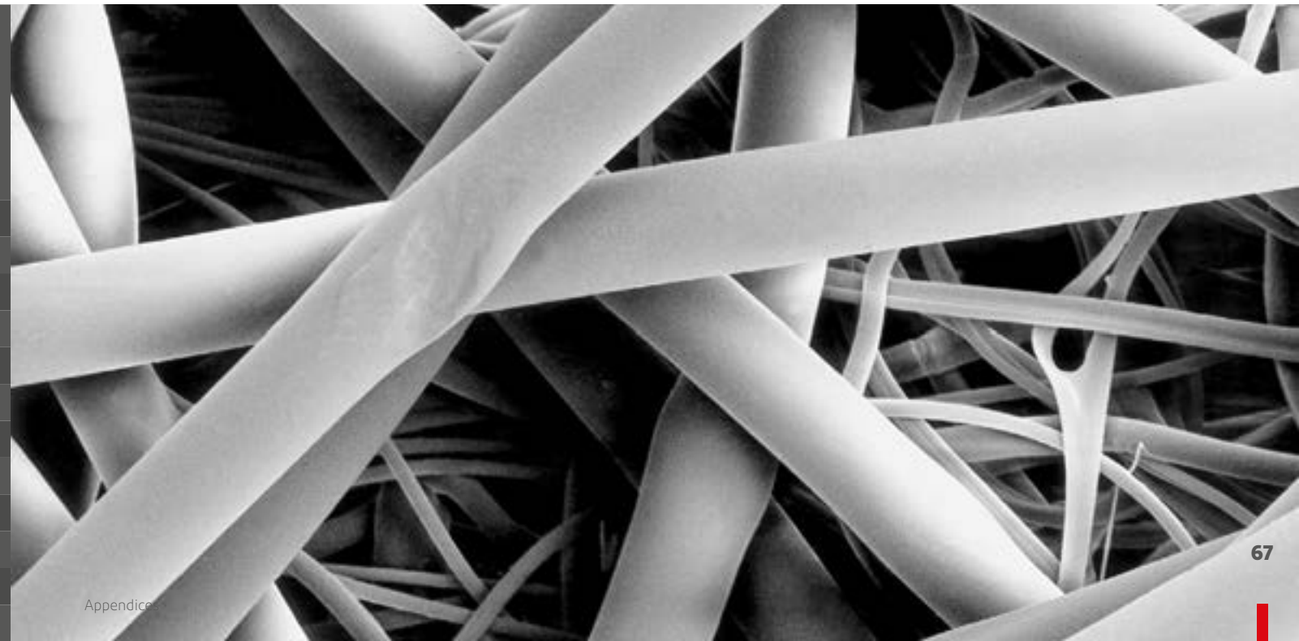
6

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 protectionprovided. And even where staff are wearing the appropriate equipment, if it doesn't fit or if it isn't comfortable then it is often being worn incorrectly. Identifying the appropriate protective and mechanical performance, yet, at the same time, maximising wearer comfort is a critical part of the selection equation and will significantly contribute to correct coverall use with optimised wearer satisfaction and productivity. As with protection-in-use (please see Step 5) it is essential that donning and doffing procedures are developed and practised (Step 8) and user wear trials (Step 9) are conducted to assess the perceived comfort-in-use of the garment(s) being considered.

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.



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.

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)

Step

9

Wear test

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

Recommended donning & doffing procedures from DuPont for chemical protective clothing

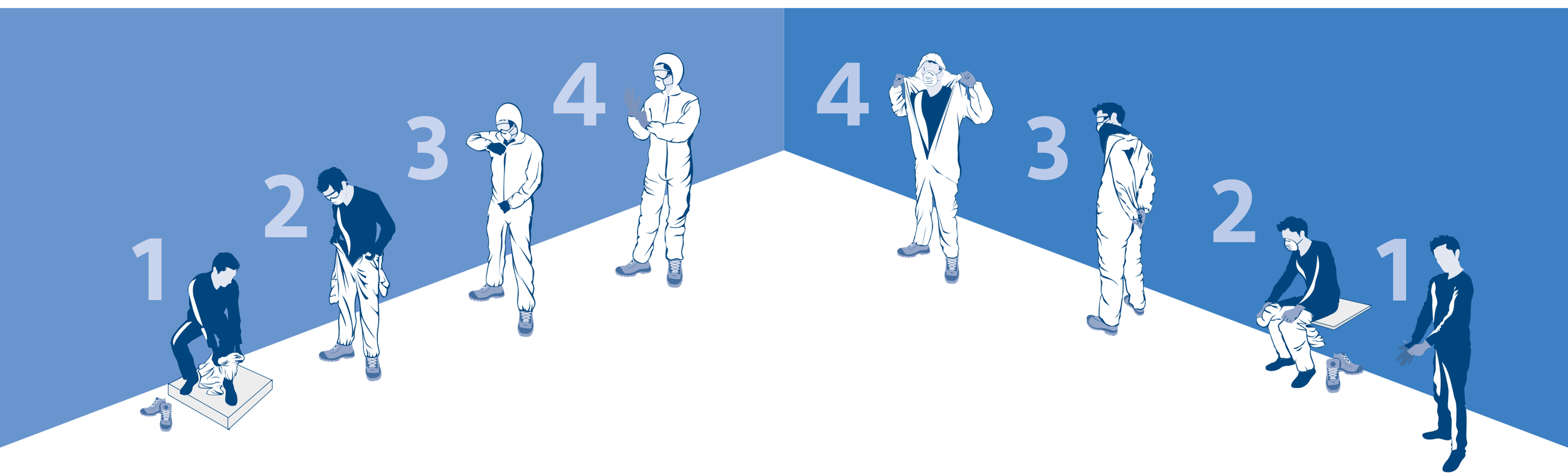
Follow the steps recommended below to dress and undress in a safe and simple manner, thereby limiting any potential for contamination after working in a hazardous environment.

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



GARMENT WITH SHOE COVER SYSTEM ONLY

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**
The first two characters are the fabric description. *Abbreviations* **DuPont™ Tychem®** **TK** 10000 **TP** 6000 FR **TF** 6000 **TYF** 6000 **SL** 4000 **QC** 2000 **99** Accessories **DuPont™ Tyvek®** **TJ** 800 J **TY** 600 **TY** 500 **TY** 400 **TD** 400 D **DuPont™ ProShield®** **PS** 60 **PS** 20 **PS** 20 SFR **PS** 8 Proper **PS** 4 Practik	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.	*Abbreviations* **S** Serged or Sewn **B** Bound **T** Taped or Double Taped See page 15 for details.	Several DuPont fabrics are available in color options. *Abbreviations* **BU** Blue **GR** Green **GY** Gray **LY** Lime Yellow **OR** Orange **SV** Silver **TN** Tan **WH** White **YL** Yellow	Many DuPont garments are available in a range of sizes; refer to catalog descriptions for details. *Abbreviations** **SM** Small **MD** Medium **LG** Large **XL** Extra large **2X** 2 Extra large **3X** 3 Extra large **4X** 4 Extra large **5X** 5 Extra large **6X** 6 Extra large **7X** 7 Extra large **00** Universal See page 16 for sizing charts.	The number of garments per case.	*Abbreviations such as* **TV** Trade Agreement Act compliant **VP** Vend packed Not all option codes are available for all products; refer to catalog descriptions for details. See next page for abbreviations.

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.

Make to Stock / Order designations are based on sales volume and production efficiencies. Therefore, designations are subject to change without notice.

Please refer to our price lists for more detailed information.

* Not all sizes are available in all styles.

Product Part Numbers

Option code abbreviations

00 Standard offering

0B Bulk pack

2K Double storm flap w/zipper & hook-and-loop closure

5C Showa Best® 892 outer glove

5V Showa Best® 890

7C MSA connector pass-thru CAMDS (#491335) right side

7M MSA dual purpose w/Foster fitting 990060

7N MSA quick fill w/Schrader fitting 990190

7R MSA dual purpose #495670 Hansen fitting (left front waist)

7S Scott® pass-thru #803620-01 Hansen fitting (right side)

7W Interspiro pass-thru #33689006

BN Berry Amendment compliant

G1 Reduced case quantity

JF CPE sleeve cuff and jam fit glove insert

LG 8.25″ high shoe cove

NF NAFTA sourced

NP Respirator fit hood and storm flap

NS Non-skid material

PI Packaged individually

SR Skid-resistant

TV Trade Agreement Act compliant

VP Vend packed

WG With gloves

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 wider anging quality and performance latitudes within a given Standard and these permitted margins can equate to big differences in product capabilities.

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

From this it is easily seen that the allocation of a garment to a specific protection type does not necessarily provide an indication that all suits of this type offer the same protection. It is also important to understand that a CE mark in itself does not signify 'approval' of any kind. The 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

- 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.

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.

Appendix 1

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.

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

Quality Control

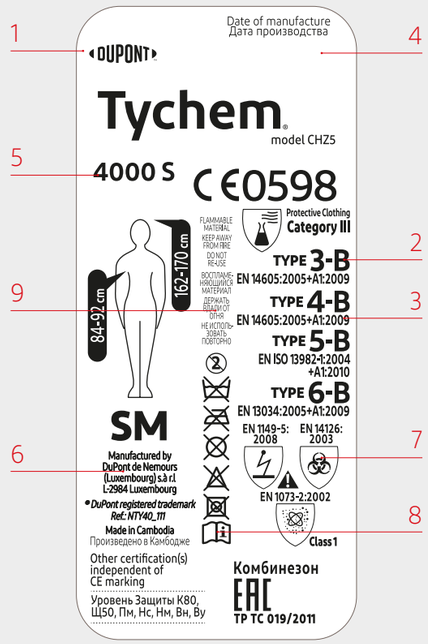
All CE-certified protective clothing has a marking (e.g. product label) and is supplied with a sheet of information by the manufacturer (i.e. Instructions for Use). The content of these two items is checked and released by the notified body that issued the CE marking for the product, and therefore these are official documents.

The manufacturer is under 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.

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).



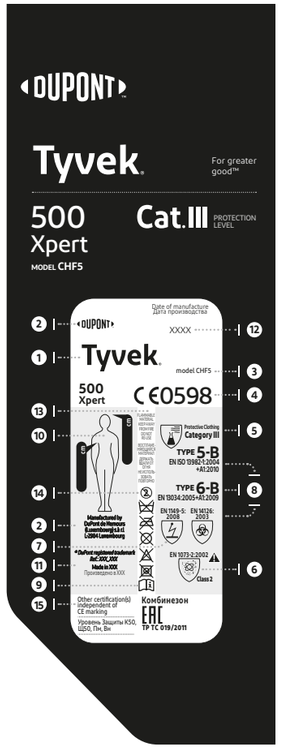
Protective garments – categories, types and classes

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:



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

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DuPont Ref.: IFUTYSXP_052

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 Confirmity (Annex IX**)	Annual Quality Surveillance Certification by a notified body (Module C_2/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.**

Chemical Protective Clothing, Category III		
Type and Pictogram*	**Definition and Exposure Level**	**Product Standard and Year of publication**
TYPE 1 **TYPE 1 - ET**	Gas-Tight TYPE 1 – Protective clothing against liquid and gaseous chemicals, including liquid aerosols and solid particles. TYPE 1 - ET – Performance requirements for emergency teams.	EN 943-1:2019** 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.

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

Notes

For information on radioactive particulate protection please see Appendix 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

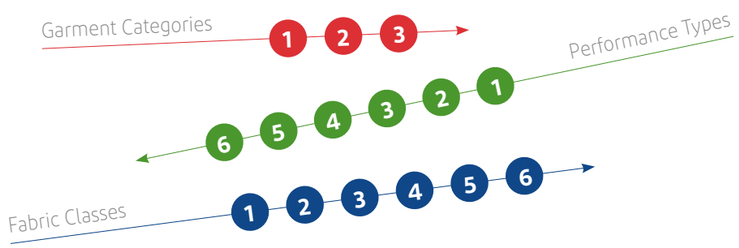
Table 5 **Mechanical performance tests.**

	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.
Durability	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.
Durability	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.
Durability	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.
Durability	Puncture resistance	EN 863	Puncture records the maximum force required to push a spike through the fabric with a constant rate until it perforates.
Durability	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.
Protection	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.
Protection	Surface resistance	EN 1149-1	Antistatic test method is intended for materials used for electrostatic dissipative protective clothing to avoid incendiary discharge. A potential is applied to an electrode assembly rested on the fabric placed on an insulating base plate and the resistance of the fabric is recorded. The lower the resistance, the better the electrostatic dissipation performance.

A word of caution

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

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



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/m^2
Thickness	EN ISO 534	µm
Resistance to water penetration	EN 20811	cm H_2O
Bursting strength	ISO 2758	kPa
Air permeability (Gurley)	ISO 5636-5	s
Water vapour resistance, Ret	EN 31092	$m^2.Pa/W$

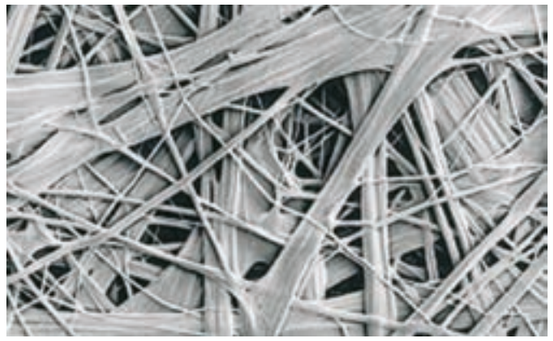
Table 6 **Minimum requirements for CE properties versus Type and informational characteristics.**

	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
Durability	Flex cracking resistance	EN ISO 7854 Method B	cycles	X	Class 1 >1000 cycles	Class 1 >1000 cycles	Class 1 >1000 cycles
Durability	Tear resistance	EN ISO 9073-3	N	Class 1>10 N	Class 1>10 N	Class 1>10 N	Class 1>10 N
Durability	Tensile strength	EN ISO 13934-1	N	Class 1>30 N	X	Class 1>30 N	Class 1>30 N
Durability	Puncture resistance	EN 863	N	Class 1>5 N	Class 1>5 N	Class 1>5 N	Class 1>5 N
Durability	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
Protection		EN ISO 6530	%	Class 3>95%	X	X	X
Protection	Permeation by liquids	EN ISO 6529 Method A	min	X	X	Class 1>10 min	Class 1>10 min
Protection	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®

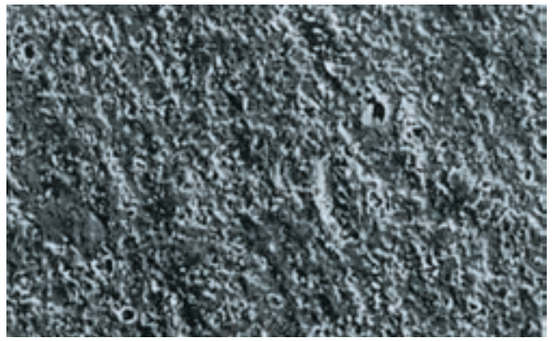
Manufactured by a flash-spinning process, Tyvek® fabric is made of strong, continuous, high density polyethylene fibres. The fibres are thermally bonded into a tight, homogeneous and soft fabric that is intrinsically breathable, does not shed fibres ('linting') and has inherent barrier properties i.e. 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)

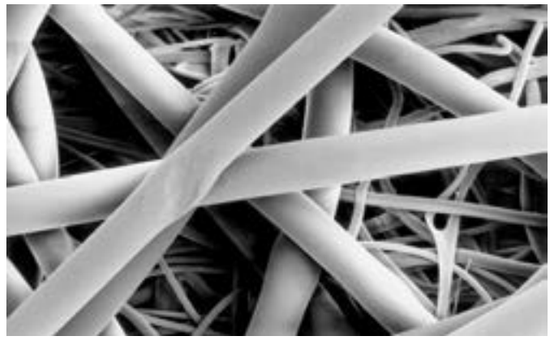
MPF fabrics are a bi-laminate material comprising a thin microporous film bonded to a spunbound polypropylene base. These fabrics offer limited durability since all barrier protection is lost when the protective film layer is abraded. In addition, their low air-permeability characteristics make then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



1:500 **Source:** DuPont.

Spunbound/Meltblown/Spunbound (SMS)

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

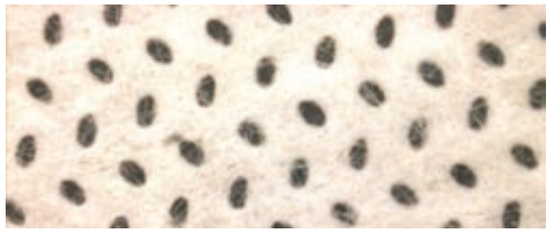
The figure illustrates fabric durability after 10 cycles of abrasion. At first glance SMS fabric remains unaffected but it has lower performance level. MPF protection barrier is impacted . The film gets abraded very easily and one can see that there are holes in the film. Only Tyvek® remains unaffected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

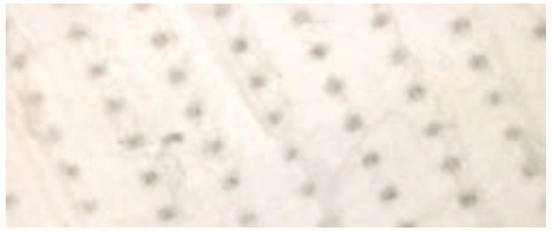


Figure 1 Abrasion: Simulation of wear and tear in everyday use, **Source:** DuPont

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.

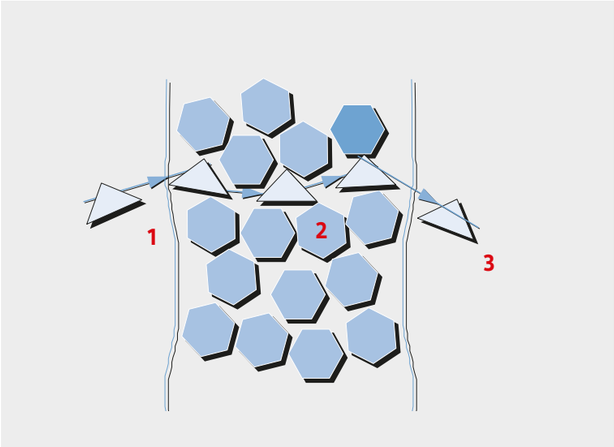


Figure 3 Permeation, **Source:** DuPont

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.

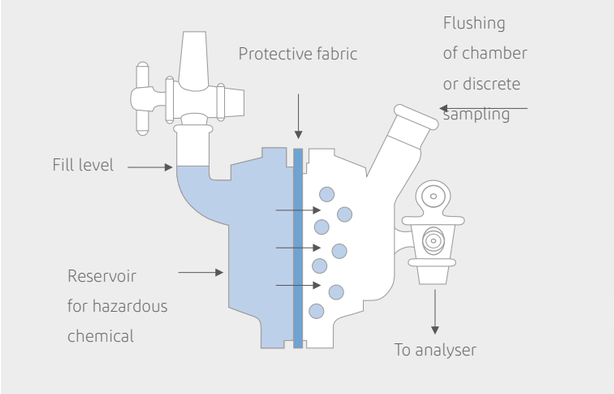


Figure 4 Permeation test cell, **Source:** DuPont

Permeation rate

This is the speed at which the test substance permeates through the test fabric. Permeation rate is expressed as mass of the test substance (µg) flowing through the fabric area (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 weartime may be longer or shorter than the breakthrough time depending on the permeation behaviour of the substance, its toxicity and the exposure conditions. In case of mixtures, permeation is measured for the most toxic substance since permeation cannot be measured for chemical mixtures. Account must be taken of the fact the permeation characteristics of mixtures can often deviate considerably from the behaviour of the individual chemicals. Furthermore, permeation rates are temperature dependent and typically increase with a temperature rise.

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

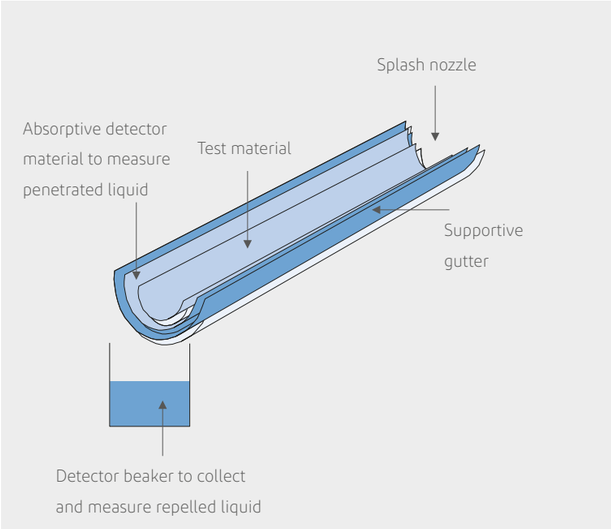


Figure 5 Gutter Test, **Source:** DuPont

No chemical permeation data for your chemical?

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

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

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

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.

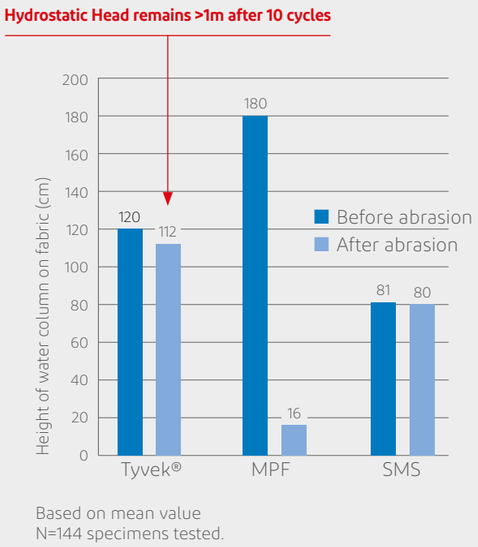


Figure 6 Liquid barrier performance. Hydrostatic Head: EN 20811. Before and after 10 cycles of abrasion (EN 530 - Method 2), **Source:** Independent Institute

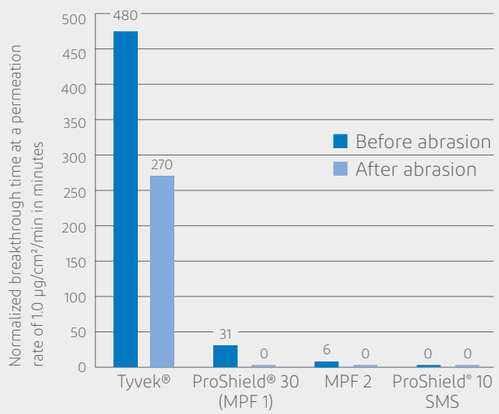


Figure 7 Permeation resistance to sulfuric acid 18%, **Source:** Independent Institute

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 aurus) material onto the fabric and subjecting it to mechanical rubbing. Due to the combined effect of rubbing and liquid migration, bacteria may spread from the donor material through the fabric down to the agar surface.
	Resistance to penetration by contaminated aerosols	ISO/DIS 22611	The test method exposes a material to a bacterium (Staphylococcus aurus) suspended in an aerosol and sprayed onto both an unshielded filter and one shielded with the test material. The ratio of bacteria found on the shielded (bacteria passed through) and unshielded (background bacterial count) filter is used to assess the barrier properties of the test material.
	Resistance to penetration by contaminated solid particles	ISO 22612	A portion of talc contaminated with Bacillus subtilis spores is poured on the fabric and captured on a sedimentation plate (Petri dish) after vibration for 30 minutes. After 24h incubation of the sedimentation plate, the number of colonies produced are counted.

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

Table 11 **Protective clothing Types according to EN 14126:2003.**

Type	Description	Relevant standard
1a-B, 1b-B, 1c-B	Gas-tight	EN 943-1:2019, 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 principlethat strongly applies to protective garments. A first class barrier fabric will be severely compromised if it forms part of a coverall with weak seams, unreliable closures and poor ergonomics. For this reason it is important that whole-garment tests are conducted to indicate protective performance and wearability in use.

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

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 '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.

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, penetrationspots at a maximum of 3 cm² of the test liquid are allowed on the undergarment.

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

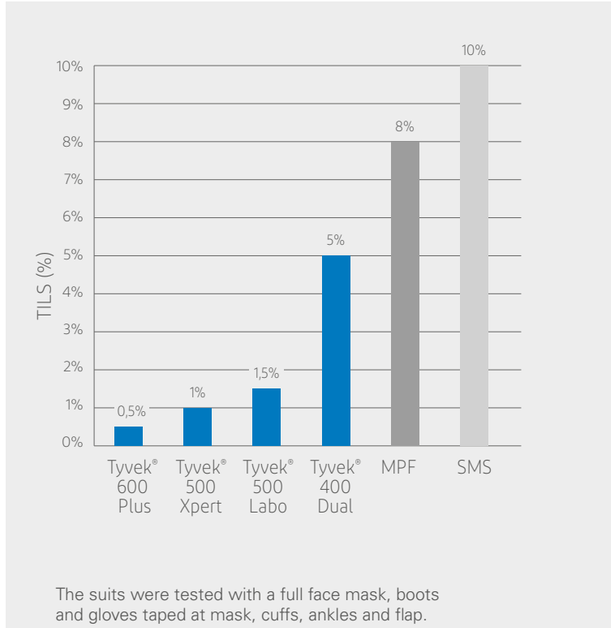


Figure 8 Total Inward Leakage (TILS): Average of the 10 suits and all activities EN ISO 13982 - (1 and 2). Dry particles Sodium Chloride NaCl 0,6 µm, **Source:** Independent Institute

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.

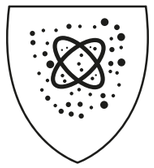
Whole-suit Type Tests

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.



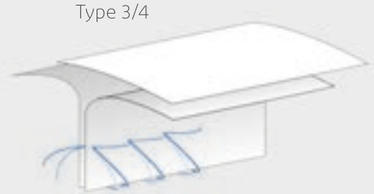
Whole garment performance

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.

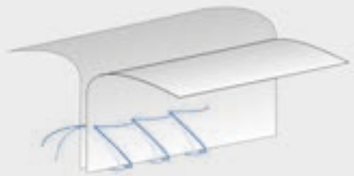
Type 3/4



Stitched & Overtapes seams

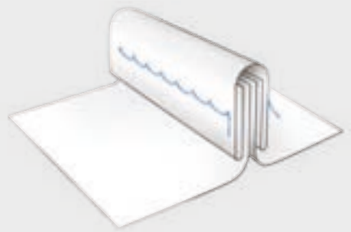
Seams can be stitched and overtaped. The tapes used for DuPont products with this type of seam offer a barrier equal to that of the fabrics.

Type 5/6



Stitched seams

Stitching offers good balance between seam strength and seam barrier.



Bound seams

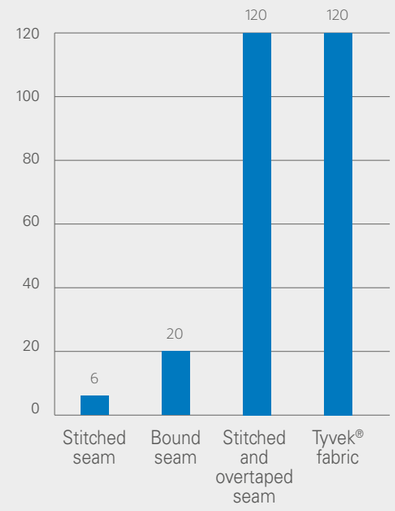
Seam construction leaves the needle holes visible. Construction is unlikely to offer permeation barrier equal to the fabric.

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.

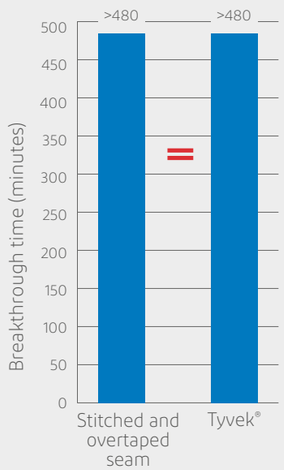


N=16 specimens tested

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.



N=16 specimens tested

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

Comfort considerations

Key comfort factors

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

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

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

The need for comfort

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

Discomforting costs

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

Finding the optimum balance

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

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

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

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.

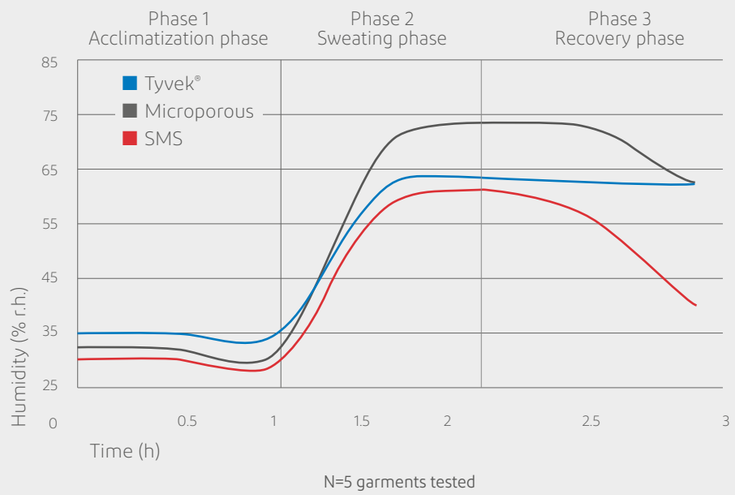


Figure 12 Humidity between underwear and garment (by family)
Source: Independent Institute

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	Ethylene	Acetylene
Benzene	Ethylene oxide	Hydrogen
Toulene	Diethyl ether	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.

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

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

Single-sided versus double-sided

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

Atex Directives

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

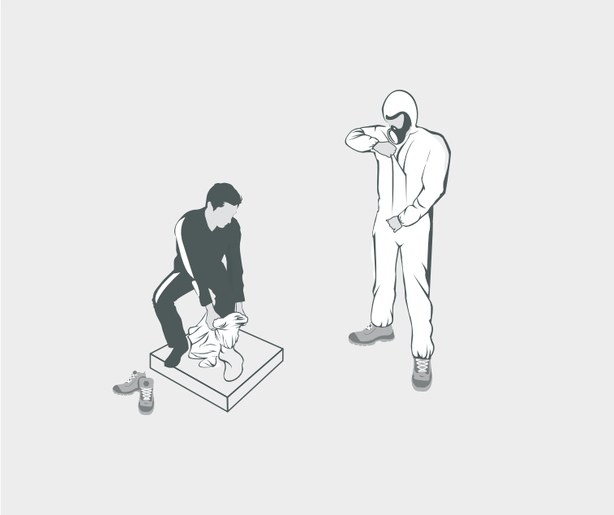
For the antistatic performance data relating to a particular product please refer to the relevant technical data.

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 or unduly prolonged storage conditions can directly affect a product's functional performance and provisions must always be made to ensure that adequate storage and renewal provisions are in place.

Garment 'Shelf Life'

The 'shelf life' of a protective garment relates to it expected functional life under recommended storage conditions. It is the timespan during which a product can be used with its functional performance still intact. Different products and brands can have widely varying 'shelf lives' with some having a very limited shelf-life and others coming from suppliers that are unable to provide accurate product longevity data. This is very important, since a product with an expired shelf-life cannot be guaranteed to provide the level of wearer safety specified and their use could leave personnel with inadequate protection.
There is no official norm describing how shelf life of PPE should be determined and therefore specifiers and users must ALWAYS CHECK what manufacturer tests have been conducted and what data is available to support claims relating to product life expectancy.

Garment storage and maintenance

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

It is recommended that a nominated person is put in charge of storage and maintenance to ensure that the responsibility is not overlooked or carried our ineffectively. Employees should be educated in the correct use of all PPE and must be responsible for reporting any loss, fault or damage.
It is the employers responsibility to ensure that appropriate PPE is available at all times to employees. It is important that a PPE review, rotation and replacement programme is in place to check that protection is available and that it is within its designated shelf-life.

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

Fabric Type	Expected fabric shelf life (years)
Tyvek®	10
Tyvek® 800 J	5
Tychem® 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.

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