



Why choose Lakeland?



Secondary FR Workwear Selection Guide

This booklet provides information on Lakeland's Pyrolon™ range of Secondary FR Workwear, along with a detailed guide on testing, relative performance and selection of various options in the market to enable users to make the most effective choice.

Secondary FR Workwear is used where chemical protection is required concurrently with primary FR protection (offered by EN 11612 certified workwear). Standard chemical suits cannot be used in these circumstances as they will compromise thermal protection - therefore specialist Secondary FR workwear is required that provides both chemical protection and supports flame and heat protection.

Especially in the Oil, Gas and Petrochemical industry, secondary FR workwear is vital.

This guide provides users in this and other industries with an effective tool to ensure they are using the best coverall for the job - resulting in better targeted protection, optimal comfort and ensuring your thermal protection is not being compromised by incorrect choice of workwear combinations.

Lakeland delivers the best, most innovative Protective Clothing products and choices in the world.

Broad range of products and fabrics

The wide choice of fabrics and styles offered means users can target selected protection more specifically to their application - which means better protection, greater comfort and lower cost. Lakeland offers the right tool for the job... *because if all you have is a hammer... everything looks like a nail!*

Expertise from experience

Lakeland was the original manufacturer of non-woven based limited life clothing and remains the best. Our expertise is derived from over forty years experience of the design and manufacture of protective clothing.

World-wide presence and growth

Lakeland International is growing rapidly, with production and sales in over 40 countries. So we can bring you the best in fabrics and innovations the world has to offer.

Know the maker - we manufacture our own products

Lakeland Protects People. It is our core business. Unlike many of our competitors we don't use contractors for our key products. We make our own - so we control production and quality.

We design the fabric, we make the garment, we inspect it and we ship it.

Let us help you Protect Your People.

Introduction: The only Secondary FR Workwear you can trust

The challenge of multi-risk environments: why Pyrolon™ should be the default choice for chemical protective clothing in sectors where protecting against heat, flames *and* chemicals is the norm.

What is Secondary FR Workwear?

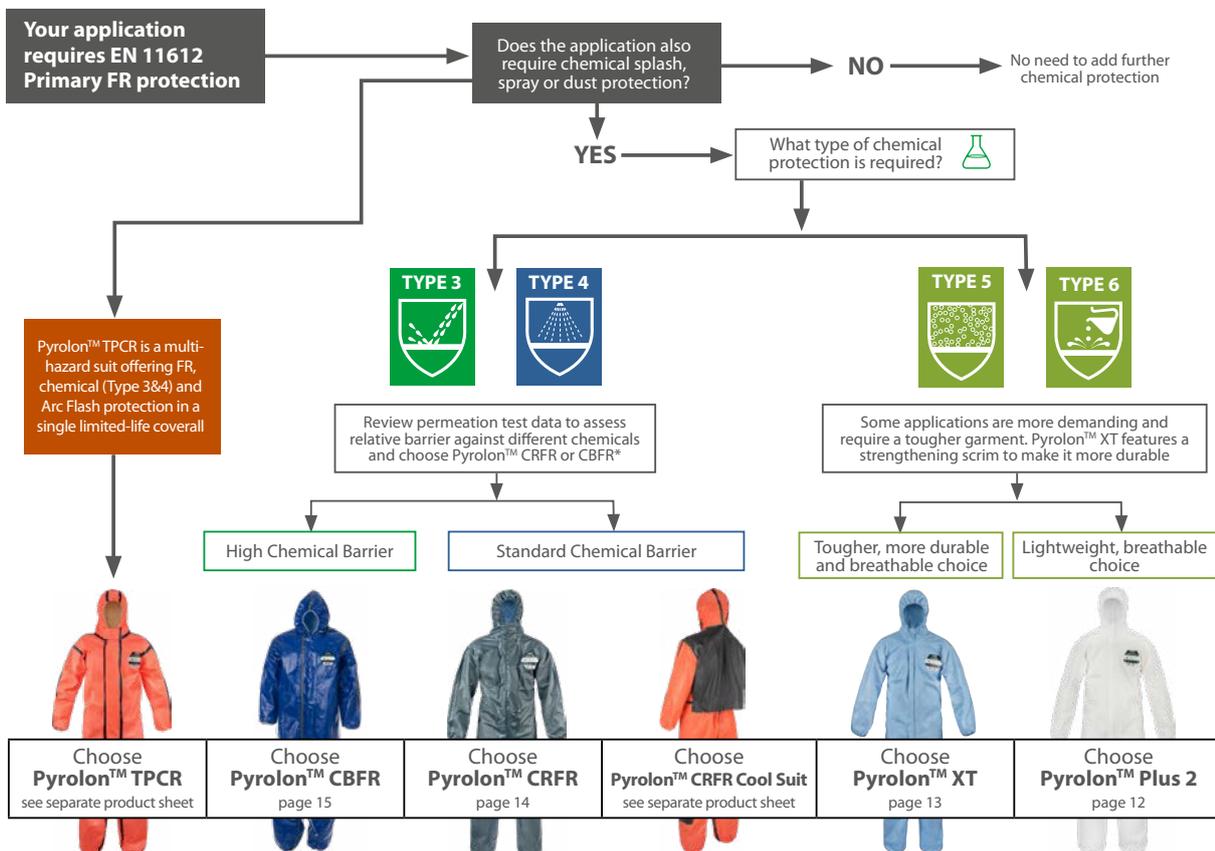
In many industrial environments the need for PPE to protect against flame and heat is common. Protection against chemicals is also often required at the same time. Secondary FR Workwear is designed to be worn **over** primary FR workwear (certified to EN 11612) to provide that chemical protection *without compromising thermal protection* - and ideally improving it.

There are **four** reasons why Pyrolon™ are *the only Secondary FR garments you can trust*:

- 1** Standard polymer-based chemical suits cannot be used over primary FR workwear; being plastic, the fabric will ignite and burn, compromising the thermal protection offered by the EN 11612 garment worn beneath (see page 7)
- 2** Pyrolon™ garments are the only Type 3 to 6 suits that are proved to not only safeguard the thermal protection offered by your EN 11612 FR suit, but to improve it! (see pages 7 & 8)
- 3** Secondary FR Workwear is certified to EN 14116. This uses a simple vertical flammability test that does not prove effectiveness either of any FR protection nor of reducing body burn when worn over Primary FR Workwear. (page 9)
- 4** Commonly available FR-treated SMS Secondary FR Workwear garments are cheap, but in FR performance show little difference from standard SMS garments and in tests show almost no reduction of predicted body burn. Further, these garments fail to fully meet the requirements of the latest EN 14116:2015 FR standard, proving their inadequacy. (page 9)

All this has been proven conclusively through the use of thermal mannequin testing; using simulated flash fire to predict the body burn resulting from different combinations of EN 11612 workwear and secondary FR workwear.

Pyrolon™ Selection Chart



* Note: that permeation test data is not an indication of safe-wear time and should not be used as such. See <https://www.lakeland.com/europe/industries/how-to-select-the-right-chemical-safety-clothing> (section 4) for more information.

What is Secondary FR Workwear?

1.0 Secondary FR Workwear

What is the purpose of Secondary FR workwear
Where and when should Secondary Fr Workwear be used?

The Hazards

Protective Clothing Required

Flame & Heat only



Primary FR Garment Certified to EN 11612

Flame & Heat + Chemical Splash



Primary FR Garment Certified to EN 11612 + Chemical Suit with FR Properties

- When & where should Secondary FR be used?**
- Secondary FR Workwear is worn when protection against both flames and chemicals are required.
 - Secondary FR garments are designed to be worn **over** Primary FR Workwear.
 - Secondary FR Garments provide chemical protection *and* feature FR Properties: the fabric and components will not ignite and burn.
 - However... Secondary FR Workwear will NOT provide flame and heat protection when worn alone; thermal protection must be provided by Primary FR Workwear.



Key Point Secondary FR Workwear is worn **over** Primary FR Workwear when flame **and** chemical protection is required *at the same time*.

1.1 Testing of Primary & Secondary FR Workwear

What tests are used to assess primary and secondary FR workwear?
Which tests provide an indication of the effectiveness of heat and flame protection?

There are **2** key CE standards for flame and heat protective workwear



EN 14116	EN 11612
Used to certify SECONDARY FR Workwear	Used to certify PRIMARY FR Workwear
<ul style="list-style-type: none"> - Consists of a single simple vertical flammability test to indicate whether a fabric will ignite and burn. - Provides no indication of any level of protection 	<ul style="list-style-type: none"> - Consists of a series of tests including heat shrinkage resistance, vertical flammability, and five optional heat resistance tests. - The above are tests ONLY on the fabric - Includes optional whole garment thermal mannequin test to EN 13506.

Other heat protection standards relate to specific application types. For example:-

- EN 11611: Clothing for welding and similar applications
- EN 61482: Clothing for protection against the heat hazards of arc flash
- EN 469: Clothing for fire-fighters

Secondary FR Workwear chemical suits may be worn over all such primary FR protection.

How are these standards and test different?
What do these tests indicate?

Testing of Primary and Secondary FR Workwear

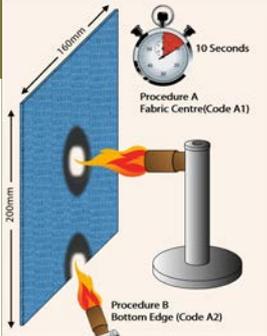
1.1 (continued)

Testing of Primary & Secondary FR Workwear

How are the tests used for EN 14116 and 11612 different?

What do these tests tell you?

Tests in EN 14116 Used to certify SECONDARY FR Workwear	
ISO 15025 : Limited Flame Spread (Vertical Flammability) Test to Procedure A	
<ul style="list-style-type: none"> - Fabric sample (200mm x 160mm) clamped vertically - Flame applied to Centre (Procedure A) for 10 seconds - Three classes or 'indexes' 	
Index 1	<ul style="list-style-type: none"> - No burning shall reach any outer edge of the sample - No molten or flaming debris - Afterflame less than or equal to 2 seconds
Index 2	<ul style="list-style-type: none"> - Same as Index 1 - No hole formation greater than 5mm
Index 3	<ul style="list-style-type: none"> - Same as Index 1 - No hole formation greater than 5mm

Tests in EN 11612 Used to certify PRIMARY FR Workwear	
ISO 17903 Heat Resistance at 180°C (Optional at 260°C)	A fabric sample is placed in an oven at 180°C (or 260°C) for 5 minutes. The sample should not ignite or melt and should not shrink by more than 5%.
ISO 15025 Limited Flame Spread (Vertical Flammability) Test to EITHER Procedure A or Procedure B	
	<ul style="list-style-type: none"> - Fabric sample (200mm x 160mm) clamped vertically - Flame applied to either centre (Procedure A) or bottom edge (Procedure B) for 10 seconds
Requirements:	<ul style="list-style-type: none"> - No flame should reach the edge of the fabric sample - No flaming or molten debris - No hole formation greater than 5mm - Afterglow should be less than/equal to 2 seconds
On Labelling:	<ul style="list-style-type: none"> - Procedure A indicated as Code A1 - Procedure B indicated as Code A2

Key Point

Both EN 14126 and EN 11612 use the ISO 15025 vertical Flammability test. The requirements for EN14116, Index 3 are the same as the requirements for EN 11612. Secondary FR Workwear garments normally achieve Index 1 - so cannot be worn next to the skin and **MUST** be worn over Primary FR Workwear.

Key Point

- Primary FR Workwear is tested according to EN 11612 which provides methods for assessing the level of protection against different heat energy types.
- Secondary FR Workwear is certified to EN 14116 using the vertical flammability test ISO 15025, in most cases achieving only the lowest pass criteria. (Index 1)
- ISO 15025 is a simple test to assess tendency to ignite and burn, providing little or no information on:
 - Effectiveness of heat protection.
 - How well the garment performs when worn **over** primary FR Workwear - the purpose for which it is designed.

EN 14116 / ISO 15025 is not an effective measure of real world performance of Secondary FR Workwear

So how can Secondary FR garments be assessed?
The answer is by testing them in the way they are meant to be used, worn **over** primary FR garments.

EN 11612 Fabric Heat Energy Resistance Tests				
Note: any ONE of the heat protection performance tests with a Class 1 result is required				
Test Standard	Code Letter	Heat Type	Description	Classes
ISO 9151	B	Convective Heat	- Small flame applied to lower surface of horizontal fabric sample - Heat calorimeter records the time until a rise of 24°C on the other side of the fabric	B1: 4.0s to <10s B2: 10.0s to <20.0s B3: 20.0 or more
Lowest class is B1, highest class is B3: the longer time taken for temperature rise the longer a garment will protect				
ISO 6942	C	Radiant Heat	- Fabric sample exposed to radiant heat source of 20-40Kw - Heat calorimeter records the time until a rise of 24°C on the other side of the fabric	C1: 7.0s to <20.0s C2: 20.0s to <50.0s C3: 50.0s to <95.0s C4: 95.0s or more
Lowest class is C1, highest class is C4: the longer time taken for temperature rise the longer a garment will protect				
ISO 12127-1	F	Contact Heat	- Fabric sample placed over heated cylinder at 250°C - Calorimeter behind fabric measure time to a rise in temperature of 10°C	F1: 5s <10s F2: 10s <15s F3: 15s
F1 is the lowest. F3 is the highest. the longer time taken for temperature rise the longer a garment will protect				
Molten Metal Splash Tests				
Objective is to indicate the mass of molten metal required to damage a layer of PVC (simulating human skin) held behind the test fabric. The greater the mass required, the better the protection.				
ISO 9185	D	Molten Aluminium Splash	- Molten aluminium at 780°C dripped onto fabric sample at 60° angle	D1: 100g <200g D2: 200g <350g D3: 350g
ISO 9185	E	Molten Iron Splash	- Molten iron at 1400°C dripped onto fabric sample at 75° angle	E1: 60g <120g E2: 120g <200g E3: 200g
D1/E1 are the lowest. D3/E3 are the highest. The fabric will protect against a greater mass of the molten metal				

What is Thermal Mannequin Testing?

1.2 Thermal Mannequin Testing

How can performance of heat protective garments be measured?

What is Thermal Mannequin Testing?

Secondary FR Workwear

- Standard testing for primary and Secondary FR Workwear provides very limited information about the effectiveness of protection in the real world. (see page 5)
- What testing is available to provide a realistic indication of whether a garment or garment ensemble will protect in the event of a real flash fire?



Thermal Mannequin Testing

- This test is the only method of assessing how well thermal protective garments perform in the real world.
- It is stated as an option in EN 11612 for primary FR workwear.
- It uses a simulated flash fire to assess how much heat energy penetrates through fabric to cause burns.
- It is the only way to assess and compare how effectively secondary FR garments perform when worn over primary FR garments.



How does Thermal Mannequin testing work?

A mannequin is covered with heat sensors, each designed to replicate the rate at which skin absorbs heat energy. Each sensor is attached to a computer which monitors heat energy absorbed.

The garment or combination of garments is put on the mannequin. Normal cotton underwear is often used to simulate a real world situation

The mannequin is subjected to a burn from four burners surrounding it, the burn is at a specific heat calorie level and is normally for 3 or 4 seconds.

Data on heat energy absorbed by each sensor is collected, normally for 90 or 120 seconds after the burn.

The computer can use this data to calculate, using 'Stoll Curve' analysis, where on the body pain or a burn would have occurred, indicating 1st, 2nd and 3rd degree burns.



Scan the QR Code to watch the 'thermal mannequin test video'



What does Thermal Mannequin testing tell you?



Thermal mannequin testing provides:-

- A 'predicted Body Burn' map showing the front and rear of the body colour coded to indicate where pain, 1st, 2nd and 3rd degree burns would have occurred with a 50% probability.
- A total Predicted Body Burn
- Thus it provides a real indication of how well thermal protective garments, or combinations of Primary and Secondary FR garments will protect against heat energy in a real world scenario.



Thermal Mannequin Testing is the only way to assess and compare how Secondary FR Workwear actually performs when worn over primary FR garments - they way they are designed to be worn in the real world.

Pages 7 & 8 - show the results of thermal mannequin testing of different garment combinations:

Page 7 - Test Bank 1: comparing a standard chemical suit with Pyrolon™ Secondary FR workwear worn over a primary FR garment.

Page 8 - Test Bank 2: comparing various Secondary FR workwear types worn over a primary FR garment.

Thermal Mannequin Testing

2.0

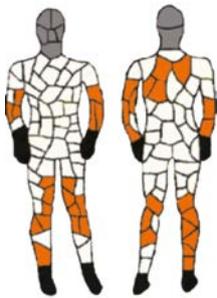
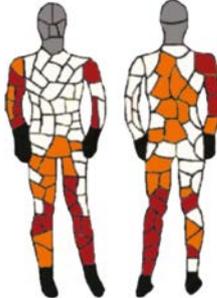
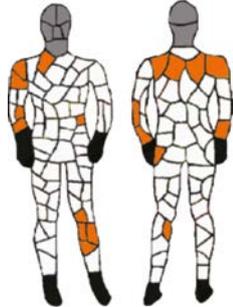
Thermal Mannequin Test Results

TEST BANK 1 | Proof that standard disposables cannot be worn over primary FR workwear but Pyrolon™ can!

Test 1 : Thermal Mannequin Test on Primary FR Workwear

Test 2 : Effect of wearing a standard disposable over Primary FR Workwear

Test 3 : Effect of wearing Pyrolon™ over Primary FR Workwear

Test 1	Test 2	Test 3
Primary FR garment worn on its own	Standard disposable worn over the same primary FR garment	Pyrolon™ CRFR chemical suit worn over the same primary FR garment
		
<ul style="list-style-type: none"> As a control a primary FR Garment (Nomex IIIA) worn on its own. The result was a predicted body burn of 37%. Only 2nd degree burns were predicted - indicated by the orange areas on the body map. <div style="text-align: center;"> <p>Test 1 Result Predicted Body Burn</p> <p>37%</p> <p>2nd degree burns only</p> </div>	<ul style="list-style-type: none"> The same test was conducted with a standard microporous film laminate coverall worn over the Primary FR Garment. The result was a total predicted body burn of 53%. 2nd and 3rd degree burns were indicated. <div style="text-align: center;"> <p>Test 2 Result Predicted Body Burn</p> <p>53%</p> <p>2nd and 3rd degree burns</p> </div>	<ul style="list-style-type: none"> The same test was conducted with a Pyrolon™ CRFR Type 3 & 4 chemical suit worn over the primary FR garments. The result was a total predicted body burn of 24%. A reduction in total burn compared to Test 2 of 35%. A reduction compared to the TPG worn alone of 55%. Only 2nd degree burns were indicated. <div style="text-align: center;"> <p>Test 3 Result Predicted Body Burn</p> <p>24%</p> <p>2nd degree burns only</p> </div>
	<p>Key Point</p> <ul style="list-style-type: none"> The result of wearing a standard disposable coverall over the Primary FR Garment is an increase in body burn from 37% to 53% - a 43% increase - and the addition of more dangerous 3rd degree burns (in dark red on the body map) This proves a standard chemical suit worn over a primary FR garment will compromise thermal protection 	<p>Key Point</p> <ul style="list-style-type: none"> The results of Test bank 1 clearly prove that standard disposable coveralls cannot be worn over Primary FR Workwear - the result is a serious compromising of thermal protection Test 3 however shows that wearing Pyrolon™ garments over Primary FR Workwear not only does not compromise thermal protection... it actually improves it.

Thermal Mannequin Testing Test Results

3.0 Thermal Mannequin Test Results

TEST BANK 2 | Performance of different types of disposable coveralls

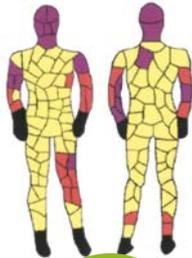
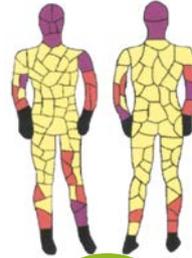
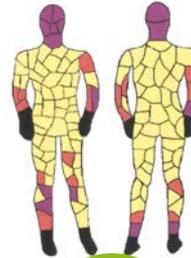
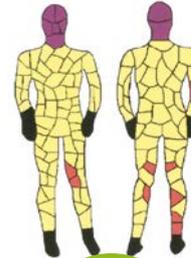
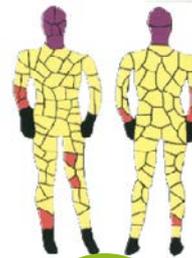
- Test 1: Flashspun Polyethylene over Primary FR Workwear
- Test 2: Standard SMS disposable over Primary FR Workwear
- Test 3: Branded FR treated SMS disposable over primary FR Workwear
- Test 4: Lakeland Pyrolon XT over primary FR Workwear
- Test 5: Lakeland Pyrolon Plus 2 over primary FR Workwear

There are TWO variations of Type 5 & 6 disposable FR coveralls available based on different types of fabric

01 FR SMS Coveralls
Coveralls made of SMS polymer fabric with a chemical based FR treatment

02 Specialist FR Coveralls
Coveralls made of specialist fabrics specifically engineered for FR Properties such as Pyrolon™

How do these types of coveralls compare with each other and with standard disposable coveralls in Thermal Mannequin Testing?
Test Bank 2 tested various disposable coverall types worn over the same primary FR Garment.

Standard Non-FR Disposable Coveralls		FR-treated SMS Secondary FR Workwear	Specialist engineered Secondary FR Workwear	
Test 1	Test 2	Test 3	Test 4	Test 5
Flashspun Polyethylene over Primary FR Workwear	Standard SMS disposable over Primary FR Workwear	Branded FR treated SMS disposable over primary FR Workwear	Pyrolon™ XT over primary FR Workwear	Pyrolon™ Plus 2 over primary FR Workwear
				
Predicted Body Burn 23.9% 3 rd degree burns	Predicted Body Burn 20.5% 3 rd degree burns	Predicted Body Burn 19.6% 3 rd degree burns	Predicted Body Burn 8.2% NO 3 rd degree burns	Predicted Body Burn 7.4% NO 3 rd degree burns
<p>less than 1% difference</p>			<p>Key Point</p> <ul style="list-style-type: none"> Both the Pyrolon™ specialist FR Workwear coveralls show predicted body burn less than half of that shown by the FR SMS coverall. Neither Pyrolon™ garments show any 3rd degree burns. In thermal mannequin testing, Pyrolon™ secondary FR workwear are the only ones that show a dramatic reduction in predicted body burn. 	
<p>Key Point</p> <ul style="list-style-type: none"> The difference in performance between the two standard non-FR coveralls and the FR treated SMS coverall is very small. The difference between the standard Non-FR SMS coverall and the FR treated SMS coverall is less than 1%. All three coveralls display 3rd degree burns. FR treated SMS secondary FR workwear shows little difference from non-FR SMS workwear. Those paying a premium for FR treated SMS coveralls over standard SMS coveralls achieve almost no difference in real world performance. 				

Thermal Mannequin Testing proves that Pyrolon™ is the only Secondary FR Workwear you can trust to work safely in the real world.

Vertical Flammability Testing

4.0 Vertical Flammability Test Results

What are the Test Requirements of EN 14116?

How do FR treated SMS garments perform compared with Pyrolon™?

The effect of changes introduced in the 2015 version of EN 14116.

EN 14116

Certification to EN 14116 for Secondary FR Workwear requires testing to the EN 15025 Vertical Flammability Test (Method A).

This applies a flame to the centre of a fabric sample for 10 seconds

The Standard requires the following MINIMUM performance:

- No burning shall reach any outer edge of the sample
- No flaming or molten debris
- After-flame less than or equal to 2 seconds

2015 Version of EN 14116



The 2015 revised version of EN 14116 introduced an important change. As well as conducting the test on the outer edge, it requires testing on the zip assembly with the following requirements:

- Same burn requirements as fabric: no dripping molten debris, no burning or melting shall reach the outer edge, after-flame less than or equal to 2 seconds.
- **The zip must function after the test.**

WHY IS THIS IMPORTANT? In the event of a flash fire removing the coverall quickly might be important. A non-functioning zip may prevent this!

How do different types and brands of disposable coveralls certified to EN 14116 perform in independent testing to these requirements?

Lakeland purchased sample garments in the market and sent them to a Notified Body for testing. Copies of test reports are available on request.

Requirement	Lakeland Pyrolon™ Secondary FR Workwear Garments											
	Pyrolon™ Plus 2			Pyrolon™ XT			Pyrolon™ CRFR			Pyrolon™ CBR		
	FABRIC	SEAM	ZIP	FABRIC	SEAM	ZIP	FABRIC	SEAM	ZIP	FABRIC	SEAM	ZIP
Flaming to edge of sample (PASS requires 'no')	NO	NO	-	NO	NO	-	NO	NO	-	NO	NO	-
Any occurrence of holes? (Index 1 allows holes)	YES	YES	NO	YES	YES	NO	YES	YES	NO	YES	YES	NO
Any flaming / molten debris? (PASS requires 'no')	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Does after flame reach edge of sample? (PASS requires 'no')	NO	NO	n/a	NO	NO	n/a	NO	NO	n/a	NO	NO	n/a
Afterflame time/s (PASS requires <2s)	0	0	0	0	0	0	0	0	0	0	0	0
Afterglow time/s (PASS requires <2s)	0	0	0	0	0	0	0	0	0	0	0	0
Zip functions after test? (PASS requires 'yes')	-	-	YES	-	-	YES	-	-	YES	-	-	YES
Overall Result (Index)	PASS (Index 1)			PASS (Index 1)			PASS (Index 1)			PASS (Index 1)		

Lakeland Pyrolon™ Secondary FR Workwear is **fully** certified to the LATEST 2015 version of EN 14116 including fabrics, seams and zips. **In all the tests**, every Pyrolon™ garment meets **all** requirements of the standard - including the tests on the zip.

Requirement	FR SMS Secondary FR Workwear Garments								
	FR SMS Coverall A			FR SMS Coverall B			FR SMS Coverall C		
	FABRIC	SEAM	ZIP	FABRIC	SEAM	ZIP	FABRIC	SEAM	ZIP
Flaming to edge of sample (PASS requires 'no')	NO	n/a	-	NO	n/a	-	TBA	n/a	-
Any occurrence of holes? (Index 1 allows holes)	YES	n/a	YES	YES	n/a	YES	TBA	n/a	YES
Any flaming / molten debris? (PASS requires 'no')	NO	n/a	YES	YES	n/a	YES	TBA	n/a	YES
Does after flame reach edge of sample? (PASS requires 'no')	NO	n/a	n/a	NO	n/a	n/a	TBA	n/a	n/a
Afterflame time/s (PASS requires <2s)	0	n/a	31	0	n/a	8	TBA	n/a	63
Afterglow time/s (PASS requires <2s)	0	n/a	0	0	n/a	0	TBA	n/a	0
Zip functions after test? (PASS requires 'yes')	-	-	NO	-	-	NO	-	-	NO
Overall Result (Index)	FAIL			FAIL			FAIL		

All FR SMS garments tested failed to meet the requirements of the latest version of EN 14116. Zip performance especially fails the test. Certification is achieved by **excluding** the requirements added in the 2015 Standard. Note: *the afterflame time for the zips on these garments: one continued to burn for 63 seconds after the flame was removed!*

Analysis of the certification of these garments shows that whilst certified these garments:-

- only meet the old version of the standard, **and/or**
- meet the requirements of the 2015 standard - **except for** specific clauses such as the zip requirements clause.

Anti-Static Properties

5.0 Anti-static Properties

What is the anti-static standard EN 1149 and how does it work?

How do Pyrolon™ garments differ from any other disposable garment?

What are the result of static dissipative tests on Pyrolon™ garments?

There are two main reasons why garments may need to be 'anti-static'

01

Garments are used in areas with explosive atmospheres of gases, vapours or dusts. A build up of a static charge could result in a spark causing an explosion.

02

Garments are used in areas with sensitive electronic equipment or product. A build up of a static charge could result in a spark which could damage the equipment or product.



The purpose of certification to EN 1149 is to ensure that a garment's **Surface Resistance** (*the tendency to resist dissipation of a static charge across its surface*) is sufficiently **LOW** to allow dissipation of a charge so that it can go to earth without generating an incendiary or damaging spark.

The Anti-Static Standard for protective clothing is EN 1149.		EN 1149 consists of 5 parts.	Part 5 contains garment requirements.	Garments are certified to EN 1149 Part 5 and tested to one of parts 1 to 4.
		Parts 1 to 4 are test methods to measure dissipative properties	Part 1: Surface Resistance (<i>ie. resistance across the fabric surface</i>) Part 2: Vertical Resistance (<i>ie. resistance through the fabric</i>) Part 3: Charge Decay (<i>ie. from a single point on the fabric</i>) Part 4: Intended as a whole garment tests (<i>does not yet exist</i>)	



Part 5 requires that protective clothing must be tested to **either** Part 1 **or** Part 3. Most disposable garments are tested according to Part 1: Surface Resistance. Part 5 defines minimum part 1 test requirements as Surface Resistance must be less than or equal to 2.5×10^9 ohms.

How are anti-static properties achieved on disposable coveralls?	Most standard disposable coveralls are made from synthetic thermoplastic polymers (usually polypropylene or polyethylene). Polymers have a high electrical resistance and will often generate static charges resulting in sparks.	Pyrolon™ garments are not based on synthetic polymers but on fibre derived from viscose (wood pulp). This has a naturally high moisture content and therefore has a naturally and intrinsic low surface resistance.
	To reduce the surface resistance manufacturers apply a chemical treatment to the fabric surface. This absorbs moisture from the atmosphere to create a thin film on its surface. Because moisture is conductive this increases surface conductivity (or reduces surface resistance).	Because Pyrolon™ are intrinsically anti-static and require no special or topical treatment, anti-static properties are superior, permanent and unlike the treatment on standard disposables will last the life of a garment.



Key Point

Because anti-static properties of standard disposable coveralls rely on a topical treatment they:-
 • are generally weak • are variable and uncertain • will rub off or fade over time • may not last the life of the garment

Test Results	EN 1149 requires a surface resistance of less than 2.5×10^9 Ohms when tested to EN 1149-1.
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Pyrolon™: EN 1149-1 Surface Resistance		
	Inside	Outside
Pyrolon™ Plus 2	52×10^6	41×10^6
Pyrolon™ XT	1.23×10^9	7.83×10^7
Pyrolon™ CRFR	60×10^4	9.4×10^8
Note: Pyrolon CBFR is tested to EN 1149-3		



Key Point

Anti-static properties of Pyrolon™ coveralls are superior to those of standard disposable coveralls:-

- they do not rely on a topical treatment like other disposable coveralls and chemical suits.
- because it is not a topical treatment properties will last the life of the garment - they will not fade or rub off.
- the results show that the surface resistance of Pyrolon™ coveralls are lower than standard coveralls.



Key Point

Even if FR properties are not required, in applications where anti-static properties are important, such as working in explosive atmospheres. **Pyrolon™ are a safer alternative.**

Oil & Gas / Petrochemical Industry

6.0 Oil & Gas/Petrochemical

Why is Secondary FR Workwear vital in this industry?
 What are the common chemical hazards and how do Pyrolon™ garments perform?
 To what chemical protection standards are Pyrolon™ garments certified to?

01 Why is Secondary FR Workwear VITAL in the Oil & Gas Industry?

- Many areas and applications need **both** Primary FR protection **and** chemical protection at the same time - standard chemical protection **cannot** be worn over primary FR workwear (see pages 6 & 7)
- Many chemicals are flammable and may generate flammable vapours - so garments that may burn or may generate static sparks could present a hazard.

Users in industries related to oil & gas and petrochemical should select garments that provide the chemical protection needed without risking compromising thermal protection and that feature effective and permanent anti-static properties.

02 What are the common chemical hazards in the Oil & Gas Industry?

- Taking into account upstream extraction and downstream cracking, processing and distribution of fuels and chemicals derived from hydrocarbons, there are thousands of chemicals in use - either as part of processing or finished products.
- However, a smaller number of essential chemicals are in common use. The table below provides a list with chemical permeation resistance for each Pyrolon™ product.

Many chemicals are flammable and may generate flammable vapours - so garments that may burn or may generate static sparks could present a hazard.

Common Chemicals Hazards In Oil And Gas Industry

results shown in minutes

Chemical	CAS No.	Basic Hazard Data	Toxicity	State	Pyrolon™ CRFR			Pyrolon™ CBFR			Pyrolon™ TPCR		
					NBT ASTM F739**	NBT EN 6529**	VP ASTM F903***	NBT ASTM F739**	NBT EN 6529**	VP ASTM F903***	NBT ASTM F739**	NBT EN 6529**	VP ASTM F903***
Acetic Acid	64-19-7	Flammable liquid and vapour. Causes severe skin burns and eye damage.	Acutely toxic	Liquid	40	45	N/A	N/A	N/A	N/A	40	45	N/A
Benzene	71-43-2	Flammable / maybe fatal if swallowed or inhaled. Skin & eye irritant. May cause genetic defects, cancers or damage to organs.	Acutely toxic	Liquid	Imm.	Imm.	>60	N/A	N/A	N/A	40	45	N/A
Ethylene Glycol	107-21-1	Harmful if swallowed.	Toxicity	Liquid	NA	NA	NA	>480	>480	NA	NA	NA	NA
Formic Acid	64-18-6	Causes severe skin burns and eye damage.	Acutely toxic	Liquid	NA	NA	NA	120	120	NA	NA	NA	NA
Hydrochloric Acid (36%)	7647-01-0	Gas under pressure - may explode. Causes severe skin burns and eye damage. Toxic if inhaled. Vapour risk (gas tight suit may be required)	Acutely toxic	Liquid	NA	NA	>60	>480	>480	NA	NA	NA	>60
Hydrofluoric Acid	7664-39-3	Fatal if swallowed or in contact with skin. Causes severe skin burns and eye damage. Fatal if inhaled.	Acutely toxic	Liquid	NA	NA	NA	>480	>480	NA	NA	NA	NA
Methanol	67-56-1	Highly flammable liquid & vapour. Toxic if swallowed, inhaled or in contact with skin. Causes organ damage.	Acutely toxic	Liquid	NA	NA	NA	25	33	NA	NA	NA	NA
Phenol (40%)	108-95-2	Toxic if swallowed, inhaled or in contact with skin. Causes severe skin burns and eye damage. May cause genetic defects and damage to organs.	Acutely toxic	Liquid	NA	NA	NA	NA	NA	>60	NA	NA	>60
Potassium Hydroxide (99%)	1310-58-3	Harmful if swallowed. Causes severe skin burns and eye damage.	Acutely toxic	Solid	NA	NA	NA	>480	>480	NA	NA	NA	NA
Sodium Hydroxide (50%)	1310-73-2	Causes severe skin burns and eye damage.	Acutely toxic	Liquid	NA	NA	NA	>480	>480	>60	NA	NA	NA

Imm. = Immediate NBT = Normalised Breakthrough Time, VP = Visible Penetration

03 Pyrolon™ Certification and Heat Resistance Performance

EN Standard	CE Type	Description	Pyrolon™ Plus 2	Pyrolon™ XT	Pyrolon™ CRFR & Cool Suit	Pyrolon™ CBFR	Pyrolon™ TPCR
Chemical Hazards							
EN 13982	Type 5	Hazardous dusts	●	●	●	N/A	N/A
EN 13605	Type 6	Light / aerosol liquid spray	●	●	●	N/A	N/A
EN14605	Type 4	Liquid spray	No	No	●	●	●
EN 14605	Type 3	Liquid jet spray	No	No	No	●	●
EN 1073-2		Radioactive contaminated dust protection	●	●	●	N/A	N/A
EN 1149-5		Anti-Static (surface resistance/charge decay)	●	●	●	●	●
Flame & Heat Hazards							
EN 14116	Index 1	no flame to reach outer edge of sample / no dripping / afterglow <2sec	●	●	●		●
EN 14116	Index 2	As above plus no hole formation >5mm					
	Index 3	As above with afterflame <2sec				●	
EN 11612		Flames & heat protection				● C1	●
Heat Transfer Classes							
	Code B	Convective heat	N/A	N/A	N/A	N/A	B1
	Code C	Radiant heat	N/A	N/A	N/A	N/A	C1
	Code D	Molten aluminium	N/A	N/A	N/A	N/A	D1
	Code E	Molten iron	N/A	N/A	N/A	N/A	E1
	Code F	Contact heat	N/A	N/A	N/A	N/A	F1
EN 61482-1-2	Arc Flash	Box method	N/A	N/A	N/A	N/A	●
EN 61482-1-1	Arc Flash	Fabric ATPV	N/A	N/A	N/A	N/A	21.9 Cal/ HRC 2
EN 11611		Welding and allied Processes	N/A	N/A	N/A	N/A	●

NOTES

- Pyrolon™ CBFR achieves Index 3 in the vertical flammability test which is equivalent to the requirements for certification in EN 11612 - the standard for PRIMARY FR workwear. It is therefore certified as such and achieves Class 1 in the Radiant Heat transfer test.
- Pyrolon™ TPCR is a multi-hazard coverall providing chemical, flame and heat and arc protection. It achieves Class 1 in all the heat. (product sheet available separately)
- CE Certificates and Declarations of Conformity can be downloaded at www.lakeland.com/europe

Use the QR Code to view a video showing burn comparisons for SMS, FR SMS and Pyrolon™ XT fabrics.



Pyrolon™ Plus 2



Flame retardant Type 5 & 6 breathable coverall

- Pyrolon garments meet the requirements of EN 14116 (Index 1) for garment for protection against flames and heat.
- Approved to the latest 2015 version of EN 14116 which requires vertical flammability testing on the zip front fastening as well as the fabric – and requires that the zip functions after the test.
- Fabric will not ignite, chars at low temperature and unlike standard disposables does not continue burning after the ignition source is withdrawn.
- Can safely be used over thermal protective garments without compromising thermal protection.
- Note that Pyrolon™ Plus 2 fabric will not ignite but is designed to wear OVER thermal protective garments and will not provide heat protection if worn alone.
- Intrinsic anti-static properties with very low surface resistance; anti-static does not wear off in use like standard disposables.
- Lakeland "Super-B" ergonomic styling – unique combination of three design elements to optimise fit, durability and freedom of movement.
- Three piece hood for rounder head shape and greater comfort.
- Inset sleeves – torso shaped to body to maximise freedom of movement and negate the need for thumbloops.
- Two piece crotch gusset – enhances freedom of movement and reduced crotch splitting.

Physical Properties

Property	EN Std	Pyrolon™ Plus 2	Pyrolon™ XT	FR SMS Brand A	FR SMS Brand B
		CE Class	CE Class	CE Class	CE Class
Abrasion Resistance	EN 530	3	2	2	1
Flex Cracking	ISO 7854	6	6	6	5
Trapezoidal Tear	ISO 9073	2	4/3	2	1
Tensile Strength	EN 13934	2/1	3/2	1	1
Puncture Resistance	EN 863	2	2	1	1
Burst Strength	EN 13938	3	2	n/a	n/a
Seam Strength	EN 13935-2	2	3	3	2

Chemical Repellency and Penetration EN 6530

Chemical	Pyrolon™ Plus 2		Pyrolon™ XT		FR SMS Brand A		FR SMS Brand B	
	R	P	R	P	R	P	R	P
Sulphuric Acid 30% CAS No. 67-64-1	2	3	3	3	3	3	3	3
Sodium Hydroxide CAS No. 1310-73-2	3	3	3	2	3	3	3	3
O-Xylene CAS No. 75-15-0	NT	NT	NT	NT	n/a	n/a	n/a	n/a
Butanol CAS No. 75-09-2	NT	NT	NT	NT	n/a	n/a	n/a	n/a

Note:-

Columns 3 and 4 contain comparative data for two commonly available FR SMS-based garment brands. The tests show that in most cases the Lakeland Pyrolon™ options feature superior properties.

However, whereas thermal mannequin testing to show predicted body burn when worn over a thermal protecting EN 11612 garment has been conducted on Pyrolon™, no such testing is available from the manufacturers of Brands A and B. Lakeland has conducted such testing for comparison purposes. The results are shown below:-

Thermal Mannequin Testing

	FSPE	Standard SMS	FR SMS	Pyrolon™ Plus 2	Pyrolon™ XT
Total % predicted body burn	23.9%	20.5%	19.6%	7.4%	8.2%
2nd degree burns	15.6%	12.8%	14.7%	7.4%	8.2%
3rd degree burns	8.3%	7.7%	4.9%	0%	0%

Note:-

1. The predicted body burn performance shows little difference between FSPE, Standard SMS and FR SMS with total body burn being close to 20% and including 3rd degree body burns of 5 to 8%.
2. The total predicted body burn for Pyrolon™ products is much lower at 7 to 8% with no 3rd degree burns apparent.
3. This proves both that Pyrolon™ products show a superior FR performance when worn over EN 11612 protective garments and that the additional cost of FR SMS garments over Standard SMS garments results in very little improvement in FR performance.

Pyrolon® Plus 2 Styles



Style code 428
Coverall with elasticated hood, cuffs, waist & ankles.

Sizes: S - XXXL



Style code L428
Coverall with elasticated hood, cuffs with thumb loops, waist & ankles.

Sizes: S - XXXL



Style code 414
Coverall with elasticated hood, cuffs, waist and attached socks.

Sizes: S - XXXL



Style code L414
Coverall with elasticated hood, cuffs with thumb loops, waist, ankles and attached socks.

Sizes: S - XXXL



Available in: White

Pyrolon™ XT



Flame retardant Type 5 & 6 breathable coverall

- Pyrolon™ garments meet the requirements of EN 14116 (Index 1) for garments for protection against flames and heat.
- Includes laminated rip-stop scrim which improves strength and durability.
- Fabric will not ignite, chars at low temperature and unlike standard disposables does not continue burning after the ignition source is withdrawn.
- Can safely be used over thermal protective garments without compromising thermal protection.
- Note that Pyrolon™ XT fabric will not ignite but is designed to wear OVER thermal protective garments and will not provide heat protection if worn alone.
- Intrinsic anti-static properties with very low surface resistance; anti-static does not wear off in use like standard disposables.
- Lakeland "Super-B" ergonomic styling – unique combination of three design elements to optimise fit, durability and freedom of movement.
- Three piece hood for rounder head shape and greater comfort.
- Inset sleeves – torso shaped to body to maximise freedom of movement and negate the need for thumbloops.
- Two piece crotch gusset – enhances freedom of movement and reduced crotch splitting.

Physical Properties

Property	EN Std	Pyrolon™ Plus 2	Pyrolon™ XT	FR SMS Brand A	FR SMS Brand B
		CE Class	CE Class	CE Class	CE Class
Abrasion Resistance	EN 530	3	2	2	1
Flex Cracking	ISO 7854	6	6	6	5
Trapezoidal Tear	ISO 9073	2	4/3	2	1
Tensile Strength	EN 13934	2/1	3/2	1	1
Puncture Resistance	EN 863	2	2	1	1
Burst Strength	EN 13938	3	2	n/a	n/a
Seam Strength	EN 13935-2	2	3	3	2

Chemical Repellency and Penetration EN 6530

Chemical	Pyrolon™ Plus 2		Pyrolon™ XT		FR SMS Brand A		FR SMS Brand B	
	R	P	R	P	R	P	R	P
Sulphuric Acid 30% CAS No. 67-64-1	2	3	3	3	3	3	3	3
Sodium Hydroxide CAS No. 1310-73-2	3	3	3	2	3	3	3	3
O-Xylene CAS No. 75-15-0	NT	NT	NT	NT	n/a	n/a	n/a	n/a
Butanol CAS No. 75-09-2	NT	NT	NT	NT	n/a	n/a	n/a	n/a

Note:-

Columns 3 and 4 contain comparative data for two commonly available FR SMS-based garment brands. The tests show that in most cases the Lakeland Pyrolon™ options feature superior properties.

However, whereas thermal mannequin testing to show predicted body burn when worn over a thermal protecting EN 11612 garment has been conducted on Pyrolon™, no such testing is available from the manufacturers of Brands A and B. Lakeland has conducted such testing for comparison purposes. The results are shown below:-

Thermal Mannequin Testing

	FSPE	Standard SMS	FR SMS	Pyrolon™ Plus 2	Pyrolon™ XT
Total % predicted body burn	23.9%	20.5%	19.6%	7.4%	8.2%
2nd degree burns	15.6%	12.8%	14.7%	7.4%	8.2%
3rd degree burns	8.3%	7.7%	4.9%	0%	0%

Note:-

1. The predicted body burn performance shows little difference between FSPE, Standard SMS and FR SMS with total body burn being close to 20% and including 3rd degree body burns of 5 to 8%.
2. The total predicted body burn for Pyrolon™ products is much lower at 7 to 8% with no 3rd degree burns apparent.
3. This proves both that Pyrolon™ products show a superior FR performance when worn over EN 11612 protective garments and that the additional cost of FR SMS garments over Standard SMS garments results in very little improvement in FR performance.

Pyrolon™ XT Styles



Style code 428
Coverall with elasticated hood, cuffs, waist & ankles.

Sizes: S - XXXL



Style code 101
Lab coat with two hip pockets, 4 stud fastening.

Size: M - XL



Style code 514
Jacket with elasticated cuffs.

Sizes: S - XXXL



Style code 016
Trousers with elasticated waist.

Sizes: S - XXXL



Style code 019
Rear entry gown with elasticated cuffs.

Size: M - XL



Style code 022NS
Overshoes with anti-slip soles.

Size: One size



Style code 023NS
Overboots with anti-slip soles and ties.

Size: One size



Available in: Pale blue

Not all styles are available from European stock in this fabric. Please contact our sales office for information on stock items.

Pyrolon™ CRFR



Stitched & Taped Seams



TYPE 3



TYPE 4



TYPE 5



TYPE 6



EN 1073-2



EN 1149-5



EN ISO 14116 INDEX 1.0

Lakeland Pyrolon™ CRFR coveralls provide a unique combination of both chemical protection to Type 3 & 4 AND meeting the requirements of flame resistance standard EN 14116 - Index 1. Pyrolon™ garments use fabric that does not burn and unlike standard Type 3 & 4 chemical protective coveralls can be worn OVER thermal protective garments WITHOUT compromising thermal protection.



- Combines Flame retardency to EN 14116 (Index 1) with Type 3 & 4 chemical protection.
- Approved to the latest 2015 version of EN 14116 which requires vertical flammability testing on the zip front fastening as well as the fabric – and requires that the zip functions after the test.
- Primarily designed to be worn over Thermal Protective Garments (TPGs - garments certified to EN 11612) without compromising thermal protection - as standard chemical suits will do.
- Outer FR PVC barrier film laminated to a proprietary nonwoven substrate of viscose rayon.
- Fabric will not ignite, burn or drip molten polymer - chars at a temperature lower than its ignition point.
- Stitched and taped seams.
- Exceptionally soft and flexible fabric for superior comfort - softer and more comfortable than most chemical suits.
- Coverall with elasticated hood, cuffs, waist and ankles. Double zip and storm flap front fastening.
- Range of other styles and accessories available.
- Lakeland 'Super-B' styling - features 3-piece hood, 2-piece crotch gusset and inset sleeves. Ergonomically styled for superior freedom of movement, comfort and durability.

Physical Properties

Property	EN Standard	Result	CE Class
Abrasion Resistance	EN 530	>2000 cycles	6
Flex Cracking	ISO 7854	>40,000 cycles	5
Trapezoidal Tear md/cd	ISO 9073	48 / 34.3 N	2
Tensile Strength	EN 13934	168 / 110N	3
Puncture Resistance	EN 863	19.2N	2
Burst Strength	EN 13938	111.8 kPa	2
Seam Strength	EN 13935-2	186.80	4

Permeation Test Data *

Liquid chemicals from EN 6529 Annex A. For a full list of chemicals tested see Permeation Data Tables or Chemical Search at www.lakeland.com/europe. Tested at saturation unless stated.

Chemical	CAS No.	Result / CE Class
Acetone	67-64-1	NT
Acetonitrile	70-05-8	NT
Carbon Disulphide	75-15-0	NT
Dichloromethane	75-09-2	NT
Diethylamine	209-89-7	NT
Ethyl Acetate	141-78-6	NT
Hydrofluoric Acid	7664-39-3	1
n-Hexane	110-54-3	NT
Methanol	67-56-1	>480 mins / 6
Sodium Hydroxide (30%)	1310-73-2	>480 mins / 6
Sulphuric Acid (96%)	7664-93-9	1
Tetrahydrofuran	109-99-9	NT
Toluene	95-47-6	NT

* NB = normalised breakthrough. This is the time taken for the PERMEATION RATE to reach 1.0µg/minute/cm² in controlled laboratory conditions at 23°C. It is NOT the point at which breakthrough first occurs. For safe use times see Selection Guide and PermaSURE®.

Because the primary concern for Pyrolon™ CRFR is the COMBINATION of chemical barrier and FR properties, its permeation barrier and testing is limited. However, more extensive penetration testing against a range of chemicals (according to test ASTM F903) is available on request.

Pyrolon™ CRFR Styles



Style code 428
Coverall with elasticated hood, cuffs, waist & ankles
Size: S - XXXL



Style code 101
Lab coat with 2 hip pockets, 4 stud fastening
Size: M - XL



Style code 514
Jacket with elasticated cuffs
Size: S - XXXL



Style code 016
Trousers with elasticated waist.
Size: S - XXXL



Style code 019
Rear entry gown with elasticated cuffs
Size: M - XL



Style code 022NS
Overshoes with anti-slip soles
Size: One size

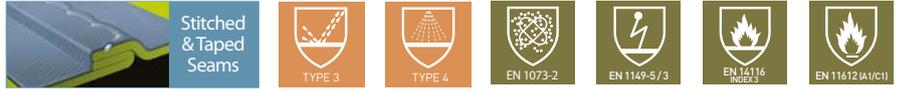


Style code 023NS
Overboots with anti-slip soles and ties
Size: One size

Bespoke styles available subject to MOQ's.

Available in: Orange Grey

Pyrolon™ CBFR



High chemical barrier Type 3 & 4 chemical suit combined with FR properties to EN 14116 – Index 3.



- Coverall with high level chemical barrier for protection against a wide range of hazardous chemicals.
- Certified as primary FR workwear to EN 11612 (A1/C1) - will provide protection against heat and flame without wearing an FR garment underneath.
- Approved to the latest 2015 version of EN 14116 which requires vertical flammability testing on the zip front fastening as well as the fabric – and requires that the zip functions after the test.
- Meets the requirements of FR standard EN 14116 – to Index 3 (As test according to EN 15025 - not index 1 as other FR disposables. Note that Index 3 is the same requirements as detailed for FR garments in EN 11612 for thermal protective garments.
- Single zip and double storm flap front fastening with hook & loop seals enabling re-use where appropriate (chemical suits should ONLY be re-used if uncontaminated and undamaged. Decision on re-use is the users' responsibility).
- Coverall with hood, elasticated cuffs, waist and ankles. Version with attached feet available.
- Lakeland "Super-B style with 3-piece hood, crotch gusset and inset sleeves for superior freedom of movement and durability.
- Double layer, cushioned kneepads for comfort and durability.

Physical Properties

Property	EN Standard	CE Class
Abrasion Resistance	EN 530	6
Flex Cracking	ISO 7854	3
Trapezoidal Tear	ISO 9073	3
Tensile Strength	EN 13934	3
Puncture Resistance	EN 863	2
Anti-static (charge decay) *	EN 1149-3	SF=0.1/HDT=0.24s)
Seam Strength	EN 13935-2	4

* Anti-static tested according to EN 1149-3 (Charge decay). Requirements in EN 1149-5 are: SF (Shielding Factor) >0.2 or Half Decay Time < 4s, so HDT of 0.24s is well within the requirement

Permeation Test Data *

Liquid chemicals from EN 6529 Annex A. For a full list of chemicals tested see Permeation Data Tables or Chemical Search at www.lakeland.com/europe. Tested at saturation unless stated.

Chemical	CAS No.	Result / CE Class
Acetone	67-64-1	NT
Acetonitrile	70-05-8	NT
Carbon Disulphide	75-15-0	NT
Dichloromethane	75-09-2	NT
Diethylamine	209-89-7	NT
Ethyl Acetate	141-78-6	NT
Hydrofluoric Acid	7664-39-3	1
n-Hexane	110-54-3	NT
Methanol	67-56-1	>480 mins / 6
Sodium Hydroxide (30%)	1310-73-2	>480 mins / 6
Sulphuric Acid (96%)	7664-93-9	1
Tetrahydrofuran	109-99-9	NT
Toluene	95-47-6	NT

* NB = normalised breakthrough. This is the time taken for the PERMEATION RATE to reach 1.0µg/minute/cm² in controlled laboratory conditions at 23°C. It is NOT the point at which breakthrough first occurs. For safe use times see Selection Guide and PermaSURE®. Because the primary concern for Pyrolon™ CBFR is the COMBINATION of chemical barrier **and** FR properties, its permeation barrier and testing is limited. However, more extensive penetration testing against a range of chemicals (according to test ASTM F903) is available on request.

Pyrolon™ CBFR Styles



Style code 228
Coverall with hood
Size: S - XXXL



Style code 214
Coverall with hood and attached feet
Size: S - XXXL

Available in: Navy blue





The Lakeland range of protective clothing provides a wide and expanding range of options for protection against the hazards of chemicals, flames and heat

This booklet provides users with a detailed guide to the importance, assessment and selection of Secondary FR Workwear.

These garments are used to provide chemical protection when worn OVER primary FR workwear without compromising thermal protection - a common requirement in the oil, gas & petrochemical industries

Standard chemical suits can not be worn in these dual-hazard circumstances as they are invariably constructed using flammable polymers, which will ignite and burn and thereby destroy the thermal protective properties provided by the primary FR workwear.

This guide will assist in ensuring the secondary FR workwear you select is effective in the real world and in ensuring you are not paying a premium for secondary FR disposable coveralls that perform little differently than standard disposable coveralls.



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