ChemMAX 3

for use in Nuclear, Biological and Chemical Environments

LAKELAND INDUSTRIES EUROPE LTD

Introduction

N.B.C suits are used in various situations where protection from Nuclear, Biological and / or Chemical hazards may be required. There is no set standard or definition of the design or configuration of an NBC suit, and the design may vary between a standard coverall featuring elasticated hood cuffs and ankles which may be worn with other PPE such as gloves, boots and face mask*, and a fully encapsulating coverall featuring attached socks, gloves and a hood with integral face shield. In this case the suit will normally require a method of attaching an air inlet from a remote air supply, such as a portable respirator, (note that in this case this air is to keep the wearer cool rather than as a supply of breathable air) and a method of allowing the air to escape, such as one-way valve. Three standard designs of ChemMAX 3 coveralls are shown in Section 2. All of these are certified to EN 14605:2004 Type 3 & 4 for protection against hazardous chemicals. ChemMAx 3 is not a gas-tight (Type 1) or “non-gas tight” (Type 2) chemical suit.

ChemMAX 3 is manufactured using a state of the art, unique multi-layer combination of films and tie layers to provide an excellent barrier to a wide range of hazardous materials whilst maintaining a fabric that is comparatively soft, flexible and quiet, thereby, compared to many similar products being relatively comfortable to wear. The aim of ChemMAX development has been to produce a range of coveralls that are donned and removed swiftly and easily and in which reasonable movement and work rates can be maintained for short periods or for unexpected exposure to hazards. Being relatively light and flexible they also take up little storage space compared to heavier suits. These garments are designed to be inexpensive enough to be disposable, but to have a long shelf life (in excess of five years in an unconditioned warehouse) so that they are ideal for organisations where exposure to NBC hazards is not the norm but is an ongoing, constant and if required likely to be a rapidly occuring risk. In such cases, examples might be fire and rescue services, ambulance services and civil defence organisations, ChemMAX 3 garments are ideal as the first line of defense, allowing operatives to don them rapidly and either escape the area or deal with the immediate situation appropriately.

Section 1: Relevant standards met by ChemMAX 3 fabric

1. ChemMAX 3 is approved to the following standards:-

    a. EN 14126: : protection against biological contaminents

    This requires five tests against a variety of biological hazards – pathogens - in different mediums such as contact and liquid contamination.

    i. ChemMAX 3 meets all of these requirements in the highest class possible.

    ii. In addition, whilst the EN14126 standard makes no requirement for sealed seams, ChemMAX 3 seams are all sealed by a two stage method involving stitching all seams with a three-thread overlocked seam, then sealing the seam with a chemical barrier tape applied with a heated roller

    iii. A summary of the tests and results on ChemMAX 3 is given in Table 1 below.

    iv. A copy of the full test report and certification to the standard is available on request

    b. EN 1073-2: 2002

    This standard is used by the nuclear industry and relates to garments for protection against dust particles contaminated with radiation (rather than against the radiation itself. This standard requires a test on the finished garment in which a test subject wearing the suit enters a spray booth which is filled with various size particles (of sodium chloride). Particle counter sensors inside the suit measure the number of particles penetrating inside the suit to produce a Total Inward Leakage (TIL). ChemMAX 3 meets the requirements of this standard.

    c. EN 14605;2005

    This standard is for Type 3 & 4 chemical protective garments. The “finished garment Type Tests” for this standard includes a simple wear test followed immediately by a “spray-booth” test in which a test subject wearing the coverall enters a spray booth and the garment is sprayed with a liquid of reduced surface tension – in the case of Type 3 garments this is a strong pressure spray from a hose nozzle to ensure no penetration occurs. This is therefor an effective test of the ability of the garment ensemble to hold out strong sprays of liquid chemicals.

    Enclosed is a copy of the ChemMAX 3 CE certificate showing the additional standard to which it is approved including EN 1149-1 for anti-static clothing

d. ChemMAX 3 has been tested against a full range of Chemical Warfare Agents according to US standard test ASTM F739-07 – which defines an 8 hour contact period so is more stringent than other similar tests (inc US military and NFPA tests). The results are given below. In every case any detection is well below the threshold used by the the US NFPA (National Fire Prevention Association) for NFPA 1994, 2007 edition, Class 2 garments.

   Enclosed in this document is a report detailing the test methods and standard used with conclusions from the testing and a summary of results. A summary of the results is shown in Table 3 below.

   Copies of the independant test reports are available on request

e. ChemMAX 3 has been tested against a wide range of hazardous chemicals to the European permeation test EN374-3 and for many of them achieves a break-through time of >480 minutes. A full list of chemicals tested is enclosed with this document and an updated list can be found at www.lakeland.com/uk/chemmax.

Section 2: Summary tables of test results

Table 1: Summary of results for EN 14126:2003 biological hazard protection*

Test Standard	Description	ChemMAX 3 Result
ISO16603:2004	Determination of the resistance of protective clothing materials to penetration by blood and body fluids - test method using synthetic blood	Pass
ISO1604:2004	Clothing for protection against contact with blood and body fluids - determination of protective clothing materials to penetration by blood-borne pathogens - test method using Phi-X174 bacteriophage	Pass (Class 6 of 6)
ISO/ DIS22611:2003	Clothing for protection against infectious agents - test method for resistance of clothing materials to penetration by biologically contaminated aerosols	Pass (Class 3 of 3)
ISO22612:2005	Clothing for protection against infectious agents - test method for resistance to dry microbial penetration	Pass (Class 3 of 3)
ISO22610:2006	Clothing for protection against infectious agents - test method for resistance to wet microbial penetration	Pass (Class 6 of 6)

** Reference: Centexbel Test Report No 8367*

Table 3: Summary of tests against Chemical Warfare Agents * and interpretation of results

Results Summary

CWA Identification	Agent	Average Cumulative Penetration after 8 Hours [*1] *(ug / cm^2)*
HD	Mustard	0.0248 *ug/cm^2*
GD	Soman	No Detection *(<0.0009 ug/cm^2)*
GB	Sarin	0.0019 *ug/cm^2*
GA	Tabun	0.00134 *ug/cm^2*
L	Lewisite	0.0858 *ug/cm^2*
VX	(nerve agent)	No Detection *(<0.00045 ug/cm^2)*

Test Specifications: NFPA 1994: Standard on Protective Ensembles for First Responders to CBRN Incidents, 2007 Edition, modified. ASTM F 739-99a: Standard Test Method for Resistance of Protective Clothing Materials to Permeation by Liquids of Gases Under Conditions of Continuous Contact, August 1999 modified. ASTM D 1776-90 Standard Practice for Conditioning Textiles for Testing, May 1990 modified.

** Tests conducted by Geomet Technologies LLC: Chemical Defence Laboratory Division ref CL09-57-DOC*

*[*1] average of three samples/ 8 hour test duration according to ASTMF739*

See following pages for interpretation of results.

CWA Testing – Interpretation of Results

- Lakeland Technical Update – April 2009

PURPOSE

Lakeland Industries has conducted chemical warfare agent testing on a number of its chemical barrier fabrics. In order to provide data that is meaningful to our customers, we conduct all of our testing per **EN 369**, "*Protective clothing – Protection against chemicals: Determination of Resistance of Protective Clothing Materials to Permeation by Liquids and Gases*" and **ASTM F739**, "*Standard Test Method for Resistance of Protective Clothing Materials to Permeation by Liquids and Gases Under Conditions of Continuous Contact*". Preconditioning is per **ASTM D1776**, "*Standard Practice for Conditioning Textiles for Testing*" (23°C, +/- 1°C and 50% RH, +/- 2%).

THE TEST METHODS

ASTM F739 and **EN 369** are both "flooded surface", continuous contact test methods that utilize analytical equipment to quantify the permeation rate and cumulative permeation for challenge chemicals. The analytical equipment used is capable of detecting the challenge chemical at permeation rates as low as 0.0015 µg/cm²/min. The primary difference between these two test methods is the point at which they require breakthrough to be reported. The permeation rate at which breakthrough time is reported is called the ***normalized permeation rate***. ASTM F739 uses a normalized permeation rate of 0.1 µg/cm²/min. while EN 369 utilizes a rate of 1.0 µg/cm²/min., ten time less stringent.

Due to the nature of the challenge chemicals involved in this testing, we asked that cumulative permeation after 8 hours be reported, not normalized permeation rates.

CONCLUSIONS

NFPA 1994, 2007 revision, "*Standard on Protective Ensembles for First Responders to CBRN Terrorism Incidents*", requires that Class 2 compliant garments have an average cumulative permeation of <4.0 µg/cm² for Distilled Mustard (HD) and <1.25 µg/cm² for Soman (GB) after one hour of exposure tested in accordance with **ASTM F739**. Lakeland conducts all of its CWA testing for 8 hours.

As our test results are in micrograms/cm² and cumulative permeation results are less than the normalized breakthrough rates for both **ASTM F739** and **EN 369** we would report the **normalized breakthrough times** as >480 minutes, and because our results for 8 hour exposure for HD and GB are less than the 1 hour cumulative permeation allowed in **NFPA 1994** [1]; we conclude that ChemMAX 3 is an adequate barrier to chemical warfare agents (HD, GD, GB, GA, L, and VX) under the conditions tested.

[1] *NFPA 1994, 2007 revision utilizes distilled mustard (HD) and Soman (GB) as representative of blistering and nerve agents respectively*

Fabric Physical Properties

Standard	Description	Result *
EN 530	Abrasion Resistance	>100 < 500 cycles (CE Class 2)
EN 863	Puncture Resistance	11.4N (CE Class 2)
ISO 2960	Burst Resistance	94.1KN/M^2 (CE Class 2)
ISO 7854	Flex Cracking Resistance	>15,000 cycles (CE Class 4)
ISO 9073	Trapezoidal Tear Resistance (md / cd)*[1]	88,2 / 50.4 N (CE Class 4 / 3)
EN 5082	Seam Strength	179.2 N (CE Class 4)
EN1149-1	Surface Resistivity (for anti static garments)	Pass (<10^{10} ohms)

* CE Classes according to EN 14325

*[1] Trapezoidal tear is measured in two directions : “md” : Machine Direction - along the fabric roll, and “cd”: Cross Direction - across the fabric roll. The two often differe because of dominant orientation of fibres in the nonwoven substrate and / or the stretch direction of any films used in the construction.

Chemical Breakthrough Times

ChemMAX 3 fabric has been tested against a number of chemical according to permeation test EN 369

Chemical	CAS No	Breakthrough in Minutes *		Chemical	CAS No	Breakthrough in Minutes*	
		A	B			A	B
Acetic Acid	64-19-7	>480	nt	Hydrogen fluoride (48%)	7664-39-3	>480	>480
Acetic Anhydride	108-24-7	>480	>480	Hydrogen Fluoride	7664-39-3	>480	nt
Acetone	67-64-1	>480	nt	Hydrogen Fluoride Gas	7664-39-3	>480	nt
Acetonitrile	75-05-8	>480	nt	Hydrogen Peroxide	7722-84-1	>480	nt
Acrolein	107-02-8	>480	>480	Jet Fuel A	N/A	>480	>480
Acrylic Acid	79-10-7	>480	>480	Jet Fuel JP-8	N/A	>480	>480
Acrylonitrile	107-13-1	>480	nt	Mercury II Nitrate (1000ppm solution)	7783-34-8	>480	nt
Allyl Alcohol	107-18-6	>480	>480	Methanol	67-56-1	>480	nt
Ammonia Gas	7664-41-7	>480	nt	Methylamine	74-89-5	>480	nt
Ammonium Hydroxide (29.4%)	1336-21-6	130	nt	Methyl Bromide	74-83-9	>480	>480
Amyl Acetate	628-63-7	>480	>480	Methyl Chloride Gas	74-87-3	>480	nt
Aniline	62-53-3	>480	>480	Methyl Mercaptan	74-93-1	>480	>480
Benzene	71-43-2	>480	nt	MDA - Methylene Dianiline	101-77-9	>480	>480
Bromine	7726-95-6	imm.		MDI - Methylene Diphenyl Diisocyanate	101-68-8	>480	>480
1,3-Butadiene	106-99-0	>480	nt	Methyl Ethyl Ketone	78-93-3	>480	>480
n-Butyl Ether	142-96-1	>480	>480	Methyl Methacrylate	80-62-6	>480	>480
Carbon Disulfide	75-15-0	>480	nt	Nitric Acid	7697-37-2	>480	nt
Carbon Monoxide	630-08-0	320	nt	Nitrobenzene	98-95-3	170	nt
Chlorine Gas	7782-50-5	>480	nt	Nitrogen Dioxide	10102-44-0	>480	nt
Chlorobenzene	108-90-7	9	57	Oleum	8014-95-7	>480	nt
Cyclohexane	110-82-7	>480	>480	Phenol	108-95-2	>480	nt
1,2-Dichloroethane	107-06-2	>480	nt	Phosphoric Acid	7664-38-2	>480	nt
Dichloromethane	75-09-2	>480	nt	Phosphorus Trichloride	7719-12-2	20	imm.
Diesel Fuel	68334-30-5	>480	nt	Potassium Chromate(sat.)	7789-00-6	>480	>480
Diethylamine	109-89-7	imm.	nt	Propylene Oxide	75-56-9	>480	>480
Dimethyl Formamide	68-12-2	>480	nt	Sodium Hydroxide (50%)	1310-73-2	>480	nt
Dimethylsulfoxide	67-68-5	>480	>480	Styrene	100-42-5	>480	nt
Dinoseb	88-85-7	>480	>480	Sulfuric Acid (30%)	7664-93-9	>480	nt
Epichlorohydrin	106-89-8	>480	nt	Sulfuric Acid (96%)	7664-93-9	>480	nt
Ethanol Amine	141-43-5	>480	>480	Sulfur Dioxide	7446-09-5	>480	>480
Ethyl Acetate	141-78-6	>480	nt	Sulfur Trioxide	7446-119	80	nt
Ethyl Benzene	100-41-4	>480	nt	Tetrachloroethylene	127-18-4	>480	nt
Ethylene Dibromide	106-93-4	>480	>480	Tetrahydrofuran	109-99-9	>480	nt
Ethylene Glycol	107-21-1	>480	>480	Thionyl Chloride	7719-09-7	imm.	25
Ethylene Oxide Gas	75-21-8	>480	nt	Titanium Tetrachloride	7550-45-0	>480	>480
Fluorobenzene	462-06-6	>480	>480	Toluene	108-88-3	>480	nt
Formaldehyde	50-00-0	>480	nt	Trichlorobenzene	120-82-1	>480	>480
Formic Acid	64-18-6	>480	>480	Trichloroethylene	79-01-6	>480	nt
Gasoline	86290-81-5	>480	nt	Trifluoroacetic Acid	76-05-1	>480	>480
HDI - Hexamethylene Diisocyanate	7550-45-0	>480	>480	Vinyl Acetate	108-05-4	>480	>480
n-Hexane	110-54-3	>480	nt	Vinyl Chloride	75-01-4	>480	nt
Hydrochloric Acid	7647-01-0	>480	nt	Xylene	1330-20-7	>480	>480
Hydrogen Chloride Gas	7647-01-0	>480	nt				

* Breakthrough in minutes “A” is the time for the rate of permeation through the fabric to reach 1.0 ug / cm2 /min
* Breakthrough in minutes “B” is the time for cumulative permeation to reach150ug (nt = not tested+
* “imm” = immediate / “nt” = not tested - data not recorded.

Section 3: ChemMAX 3 standard suit designs

Three standard suit designs for ChemMAX 3 are available. All three are approved and certified to CE standard EN 14605:2005 for Type 3 & 4 garments

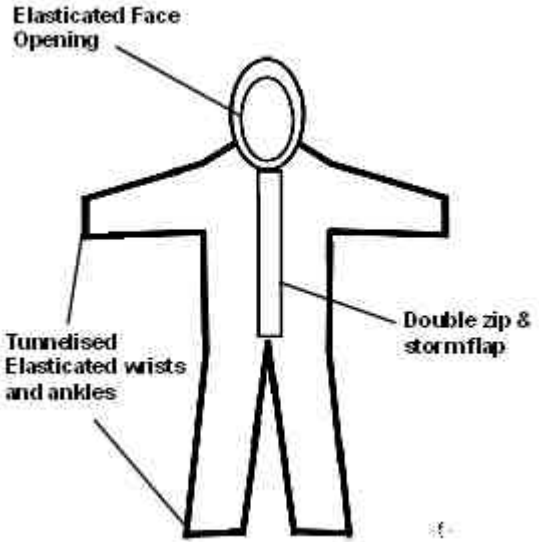
ChemMAX 3 (Standard Coverall)

Standard disposable protective coverall. Features including:-

* Elasticated face opening (to fit standard face masks)

* Tunnelised elasticated cuffs and ankles

* Double zip & storm flap front fastening



ChemMAX 3 Plus

Enhanced disposable protective coverall. Features including:-

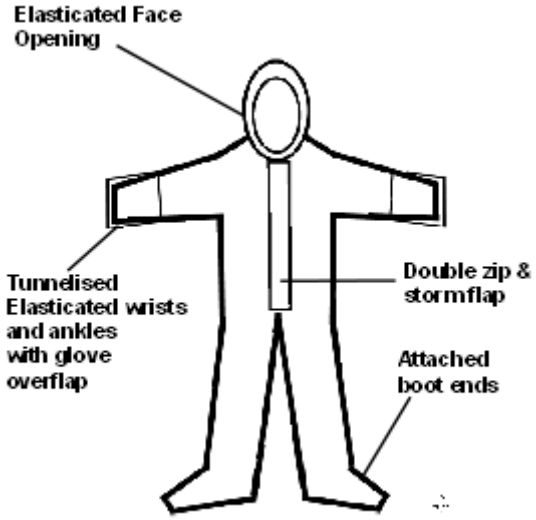
* Elasticated face opening (to fit standard face masks)

* Tunnelised elasticated cuffs

* Double zip & storm flap front fastening

* Double cuff including flap for covering gloves

* Attached boot ends



ChemMAX 3 ECP

Fully encapsulating coverall. Features including:-

* Hood with full-face PVC visor

* Tunnelised elasticated cuffs

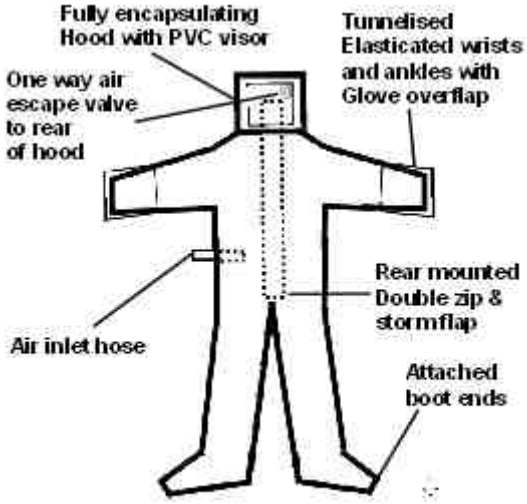
* Rear mounted double zip & storm flap fastening

* Double cuff including flap for covering gloves

* Attached boot ends

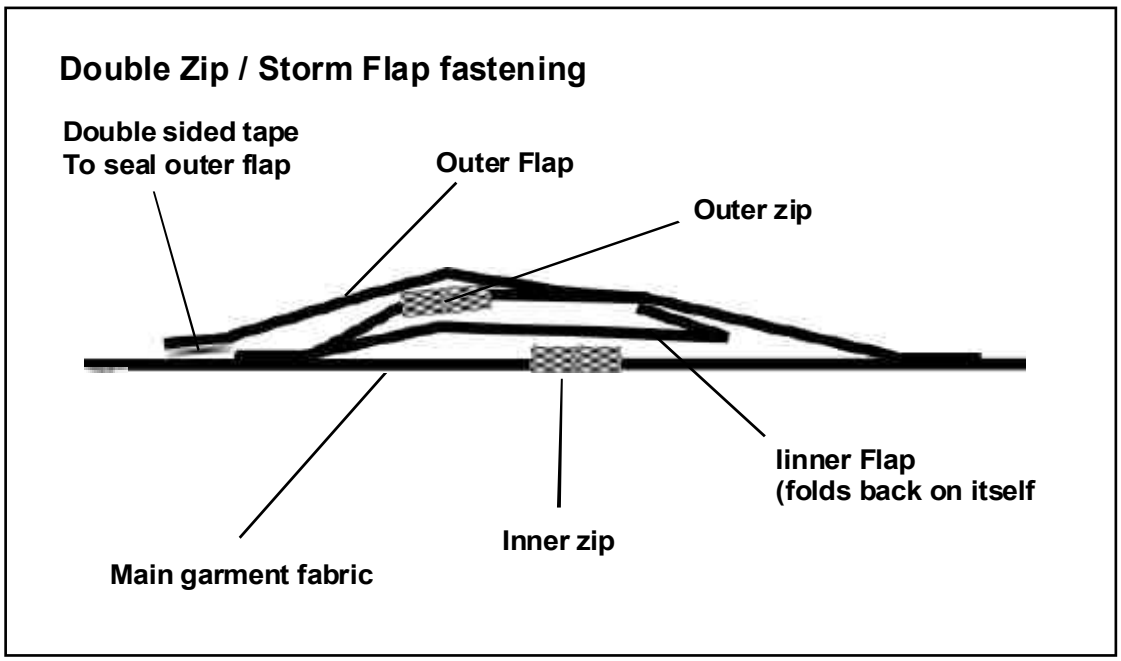
* Air inlet hose to rear of garment

* One-way air outlet valve to rear of hood



Special design Features

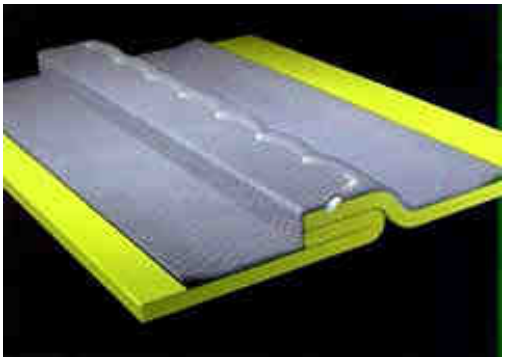
Double zip / Storm flap fastening
(Front mounted on ChemMAX 3 & ChemMAX 3 Plus / Rear mounted on ChemMAX 3 ECP)



Seams

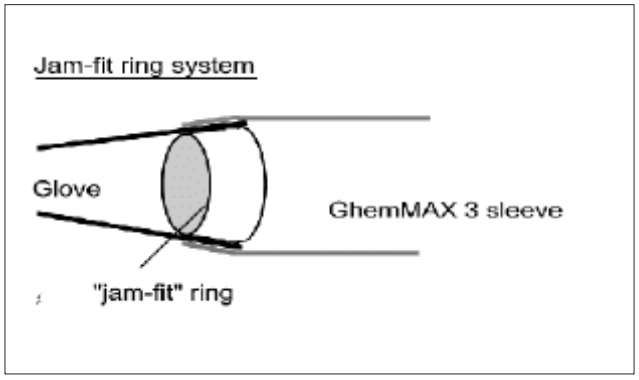
ChemMAX 3 seams are first stitched with a 3 thread overlocked seam then sealed with a PE chemical barrier tape to provide a full seal.

Seams have been tested for permeation against chemicals according to EN 374-3 to confirm they are fully sealed against liquid ingress.



Optional attached gloves using jam fit assembly

Lakeland gloves in latex, nitrile or neoprene (pictured) can be attached using a “jam-fit” ring assembly



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