3M™ Protective Coveralls: Liquid Permeation and Physical Data Revision 1: Initial Issue

Purpose

The 3M™ Protective Coveralls are designed to be used as a physical barrier to help prevent skin contact from liquid splashes and dust in certain work environments.

The purpose of this technical data bulletin is to provide information on protective coveralls to assist industrial hygienists, safety engineers and other qualified professionals in determining suitability for specific operations.

Background

The US Occupational Safety and Health Administration (OSHA) Personal Protective Equipment Standard (29 CFR 1910.132) requires employers to conduct a worksite assessment to determine if hazards are present, or are likely to be present, which necessitate the use of personal protective equipment (PPE). When conducting an assessment to determine whether PPE is needed to help prevent skin contact from liquids, there are many factors to consider. Workers handling, dispensing, using, and transporting liquid materials may need skin coverage. The worksite assessment should evaluate each task taking into account such things as whether skin contact may occur, whether it is continuous or intermittent, the nature of the contact (i.e. immersion, pressurized or non-pressurized spray, splash, surface contact, etc), accidental or intentional contact, duration of the exposure and whether the contaminant can be absorbed through the skin. There are many resources available to assist employers in conducting worksite assessments, including the OSHA PPE standard compliance guideline (29 CFR 1910 subpart I Appendix B) available at www.osha.gov.

Once a worksite assessment has been completed appropriate controls can be selected. Consideration should be given to eliminating the hazard by substituting a less hazardous material, making job or process changes or by implementing other types of controls. If PPE must be used, there are many guides and resources to assist with selection. Sources of information include publications such as the *Quick Selection Guide to Chemical Protective Clothing*[1], online databases, such as the *Recommendations for Chemical Protective Clothing* available on the NIOSH (National Institute for Occupational Safety & Health) website at www.cdc.gov/niosh/ncpc/ncpc2.html, as well as information and data from the specific PPE manufacturer.

Protective Coveralls Range: Styles and Materials of Construction

The 3M protective coveralls feature hoods, storm flaps, two-way zippers and seamless shoulders to help provide additional protection.

They are designed to be used in applications including spray painting, pharmaceutical manufacturing, wood working, health care, coating operations, insulation installation, asbestos abatement and general maintenance. Table 1 summarizes the various garment styles and fabric types used within the protective coveralls product line.

Table 1

3M™ Protective Coverall	4510	4520	4530	4540+	4565
Fabric Type	Polypropylene/ Polyethylene Laminate	SMMMS Polypropylene	SMMS Polypropylene	Polypropylene/ Polyethylene Laminate	Polypropylene/ Polyethylene Laminate
Seams	Sewn Polyester Thread	Sewn Polyester Thread	Sewn Polyester Thread	Sewn Polyester Thread	Taped Polypropylene
Cuffs	Elastic Neoprene Rubber	Elastic Neoprene Rubber	Knit Polyester	Knit Polyester	Knit Polyester
Zipper	Two-way zipper with storm flap	Two-way zipper with storm flap	Two-way zipper with sealable storm flap	Two-way zipper with sealable storm flap	Two-way zipper with sealable storm flap
Hood	Two piece hood	Three piece hood	Three piece hood	Three piece hood	Three piece hood
Other			Flame Retardant Treatment[1]	Breathable back panel	Protection against certain biohazards[2]

[1]Provides secondary protection against heat and flame. WARNING: Cuffs are not flame resistant and must be worn under gloves. Garments must be worn over primary FR garment and not be worn next to skin when FR is required.

[2]See Data in Table 4 or consult class data in Technical Data Sheets or *User Instructions*.

3M™ Protective Coveralls are designed for use in the industrial workplace. All coveralls feature elasticized waists and ankles, two-way zippers for on/off convenience, and storm flaps. Seamless shoulder and sleeve tops help provide increased comfort, and fewer potential entry points for contaminants. In addition, the designs meet ANSI 101-1996 size guidelines. The 3M™ Protective Coverall 4520, 4530, 4540+ and 4565 feature a three piece hood for additional comfort and fit. The 3M™ Protective Coverall 4530, 4540+ and 4565 feature a comfortable knit cuff.

3M™ Protective Coverall 4510 is constructed of a microporous polypropylene/polyethylene laminate to help protect against certain dust and light liquid splashes. It has basic features such as a two piece hood and elasticized cuffs, wrists, ankles and waist.

3M™ Protective Coverall 4520 is constructed of breathable SMMMS material to help reduce heat build-up and promote comfortable wear, while helping provide basic protection against certain light liquid splashes and hazardous dusts.

Designed to provide light liquid splash and dust protection, 3M™ Protective Coverall 4530 is constructed of a breathable SMMS material which is also treated with a flame retardant coating to provide secondary flame resistance. When flame resistance is needed, these garments must be worn over primary flame resistant garments. The knit cuffs are not flame resistant and must be worn under FR gloves.

The 3M™ Protective Coverall 4540+ is constructed of a microporous polypropylene/polyethylene laminate for light liquid splash and dust protection with a breathable back panel made of SMMMS material to help reduce heat build-up.

The 3M™ Protective Coverall 4565 is constructed of a polypropylene/polyethylene laminate and features taped seams. The 3M protective coverall 4565 has also been tested against ASTM F1670 for synthetic blood. See *User Instructions* for additional test data.

Permeation Testing

Permeation breakthrough time and rate are the more common factors used in assessing barrier materials to help prevent skin contact. Permeation is the process by which a chemical moves through a material on a molecular level. The test method commonly used in the protective clothing industry to evaluate permeation through barrier fabrics is ASTM F 739 *Standard Test Method for Resistance of Protective Clothing Materials to Permeation by Liquids and Gases under Conditions of Continuous Contact*. This is a laboratory permeation test whereby a swatch of fabric is placed in a test cell. One side of the fabric is exposed to a challenge chemical (liquid phase) and the other side faces a sampling chamber. If the detection equipment measures the challenge chemical on the sampling side of the fabric, the chemical has permeated the fabric. For all 3M protective coverall materials, permeation testing was performed by independent laboratories in accordance with the ASTM F739 test method. The chemicals used for testing were the liquids suggested in ASTM F 1001-99a *Standard Guide for Selection of Chemicals to Evaluate Protective Clothing Materials*. ASTM F1001 establishes a standardized list of chemicals representing a broad range of chemical classes and properties, to use in evaluating protective apparel in testing programs. Testing was conducted under laboratory conditions at room temperature. The numbers reported in this technical data bulletin are averages. Results of permeation tests can be variable. Breakthrough times and permeation rates are estimates and are not exact. This variability should be taken into account when selecting product for specific use environments. Breakthrough times through seams and closures may be lower (and permeation rates may be higher) than through the fabric. Table 2 summarizes the results of the permeation testing for 3M protective coverall 4565.

3M™ Protective Coverall 4510, 4520, 4530 and 4540+ are designed to be breathable and are not designed for long term continuous contact. Permeation testing has not been conducted on these products.

Hydrostatic Resistance Testing

Commonly in industry, hydrostatic resistance data per ASTM 751, Procedure B, is used to compare materials. This data along with other physical test data is provided in Table 4.

Repellency and Penetration Testing

Penetration is the flow of a chemical through closures, porous materials, seams, and holes or other imperfections on a non-molecular level, while repellency is the ability of a material to shed liquid that is applied to its surface. The test method used in Europe, and required in the recently released ANSI 103-2010, is ISO 6530:2005, *Protective Clothing-Protection Against Liquid Chemicals- Determination of Resistance of Materials to Penetration by Liquids.* The test method

uses a liquid splash and measures the amount of liquid that penetrates the suit materials. The method uses 10 mL of the challenge chemical applied in the form of a fine stream onto the surface of the suit material, which rests in an inclined (45°) gutter that is lined with an absorbent paper. Any liquid that is not absorbed is collected in a beaker at the end of the gutter. The challenge chemical is discharged over a period of 10 seconds via a needle to the top of the suit material. The index of penetration is the amount of liquid which penetrates the suit material within one minute expressed as a percentage original quantity poured. The index of repellency is percentage of liquid collected in the beaker after one minute. Penetration and repellency data for the protective coveralls is provided in Table 3.

Final determination as to the suitability of these products for a particular situation is the employer's responsibility. This information is subject to revision at any time. Always read and follow all *User Instructions* supplied with your 3M™ Protective Coveralls in order to ensure correct system operation. If you have questions contact 3M Technical Service.

Table 2

Summary of ASTM F739 Test Data 3M™ Protective Coverall - 4565

3M™ Protective Coverall		4565	
Fabric Type		Polypropylene, Polyethylene Laminate	
Chemical	CAS	Breakthrough time[2] (min)	Permeation Rate (ug/cm²/min)
Acetone	67-64-1	immediate	12
Acetonitrile	75-05-8	immediate	17
Carbon Disulfide	75-15-0	immediate	611
Dichloro-methane	75-09-2	immediate	27
Diethylamine	109-89-7	immediate	587
Dimethyl-formamide	68-12-2	immediate	4
Ethyl Acetate	141-78-6	immediate	304
n-Hexane	110-54-3	immediate	34
Methanol	67-56-1	immediate	2.2
Nitrobenzene	98-95-3	immediate	13
Sodium hydroxide, 50%	1310-73-2	>480	ND
Sulphuric Acid, 93-98%	7664-93-9	412	3
Tetrachloro-ethylene	127-18-4	immediate	866
Tetra-hydrofuran	109-99-9	immediate	23
Toluene	108-88-3	immediate	15

[2]Normalized breakthrough time. Defined by ASTM F739 as the time (in minutes) when the permeation rate reaches 0.1 ug/cm²/min. Breakthrough times of <10 minutes are listed as immediate.

Table 3

Repellency and Penetration Data

Coverall	4510		4520		4530		4540+		4565	
Repellency/ Penetration	R	P	R	P	R	P	R	P	R	P
Sulfuric Acid 30% (Aqueous)	>95%	<1%	>95%	<1%	>95%	<1%	>95%	<1%	>95%	<1%
Sodium Hydroxide 10% (Aqueous)	>95%	<1%	>95%	<1%	>95%	<1%	>95%	<1%	>95%	<1%

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Table 4

Summary of Physical Test Data

3M™ Protective Coveralls					
Test	4510	4520	4530	4540+	4565
Grab Tensile Strength ASTM D 751, Sec. 11, Procedure A (longitude/traverse)	12.4 lbs/ 19.9lbs	24.0lbs/ 14.6lbs	35.3lbs/ 27.8lbs	13.1lbs/ 20.6lbs	14.6lbs/ 21.2lbs
Bursting Strength ASTM D 751, Section 18	80.2N	93.7N	142.7N	89.7N	86.0N
Seam Strength ASTM D 751, Section 66 (Peak Load/Seam Strength)	8.3 lbf/ 4.2 lbf/in	10.4 lbf/ 5.2 lbf/in	18.1 lbf/ 9.1 lbf/in	12.8lbf/ 6.4 lbf/in	9.5 lbf/ 4.8 lbf/in
Trapezoidal Tear Strength ASTM D 5733 (Warp/Fill)	10.9 lbf/ 5.1 lbf	3.8 lbf/ 8.2 lbf	8.5 lbf/ 13.3 lbf	15.0 lbf/ 6.2 lbf	15.8 lbf/ 8.2 lbf
Puncture-Propagation Tear Resistance ASTM D 2582 (Machine Direction/Cross Direction)	35.5N 24.9N	19.5N 23.0N	22.6N 25.1N	37.0N 23.6N	45.7N 25.6N
Abrasion Resistance ASTM D 4157 Cycles to Rupture	1000	>3000	2150	900	850
Hydrostatic Resistance-ASTM D 751, Procedure B	1185mm	233mm	230mm	1088mm	>1479mm
CPSC 16 CFR PT 1610 Class 1 Normal Flammability	Pass	Pass	Pass	Pass	Pass
Resistance to Synthetic Blood ASTM F1670	N/a	N/a	N/a	N/a	Pass

Testing was conducted under laboratory conditions at room temperature, on the fabrics. The numbers reported in this technical data bulletin are averages. The physical data reported in this table represents averages. The data provided was tested on the fabrics

Size and Weight Chart per ANSI 101-1996 Sizing Guidelines. An appropriate size garment should be selected to allow sufficient movement for the task.

	Height		Chest	
M	66 – 69 in	167 – 176 cm	36 – 39 in	92 – 100 cm
L	69 – 71 in	174 – 181 cm	39 – 43 in	100 – 108 cm
XL	70 – 74 in	179 – 187 cm	43 – 45 in	108 – 115 cm
XXL	73 – 76 in	186 – 194 cm	45 – 49 in	115 – 124 cm
3XL	76 – 78 in	194 – 200 cm	49 – 52 in	124 – 132 cm
4XL	78 – 81 in	200 – 206 cm	52 – 55 in	132 – 140 cm

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References:

1. **Forsberg, K, Mansdorf, S.Z:** *Quick Selection Guide to Chemical Protective Clothing, 4th ed.* Hoboken, New Jersey: John Wiley & Sons, 2002.

For more information please contact:

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