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Technical Bulletin

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The Science of Protection: The Physical Testing of Chemical Protective Clothing

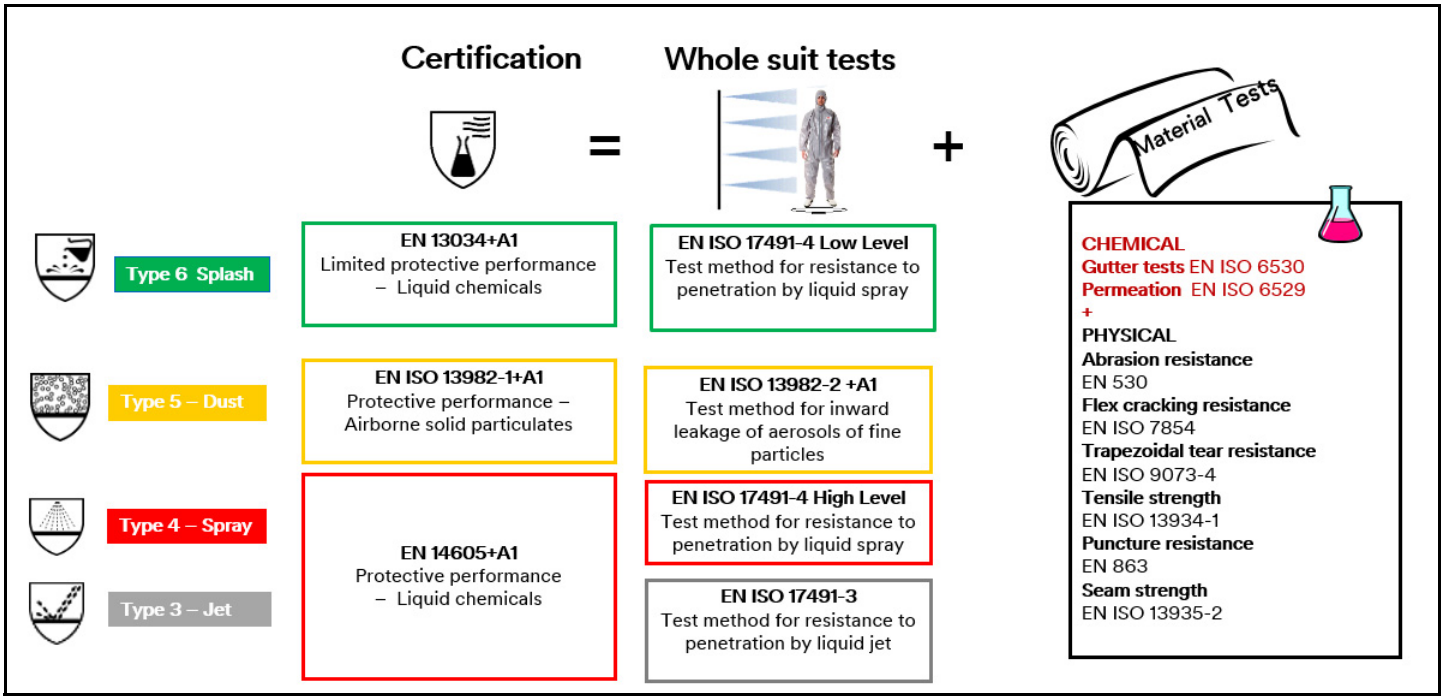
Description

3M recognizes that different jobs may require different levels of protection. This is why the range of 3M™ Protective Coveralls is diverse, and designed to provide options for your application and purpose.

In terms of protective coveralls, Body Protection normally refers to protecting the skin from the harmful effects of chemicals – either liquids or solids. This bulletin focuses on the testing of the physical properties of the fabric that is used to make the coveralls but first we will look at the three Types of coverall generally available for protection against different levels of liquid chemical hazards.

Of the six Types of Chemical Protective Clothing, three are specific to liquid chemicals and are referred to as Type 3, Type 4 and Type 6. The physical tests required for each Type are identical, however, the full suit tests do differ depending on the Type of protection they are intended to offer.

The testing requirements are laid out in each of the main European Standards for Chemical Protective Clothing:



The table above shows that the performance requirements for a Type 3, Type 4 or Type 6 coverall are to have a full suit liquid test, a seam strength test, chemical tests, and physical tests on the fabric which include the following:

- Abrasion Resistance
- Flex Cracking Resistance
- Trapezoidal Tear Resistance

- Tensile Strength
- Puncture Resistance

Each of these tests is carried out by independent specialist labs. These labs are independently assessed in order for their results to be accepted by the Notified Bodies who are authorized to issue a CE certificate for the finished coveralls. The results for each test are based on a classification system set out in EN 14325:2004. This classification system helps users select the most suitable coverall for their needs. CE certification gives users confidence that the coverall has been independently assessed as meeting the necessary Standards and that there are annual, independent checks of the production process to ensure that compliance with those Standards is maintained.

Test Methods & Performance Classification of Chemical Protective Clothing EN14325:2004					
	Abrasive Resistance	Flex Cracking	Trapezoidal Tear	Tensile Strength	Puncture Resistance
Test Method	EN 530	EN ISO 7854 Method B	EN ISO 9073-4	EN ISO 13934-1	EN 863
Unit of Measurement	Cycles	Cycles	Newtons	Newtons	Newtons
Class 6	>2,000 cycles	>100,000 cycles	>150N	>1,000N	>250N
Class 5	>1,500 <2,000	>40,000 <100,000	>100 <150	>500 <1,000	>150 <250
Class 4	>1,000 <1,500	>15,000 <40,000	>60 <100	>250 <500	>100 <150
Class 3	>500 <1,000	>5,000 <15,000	>40 <60	>100 <250	>50 <100
Class 2	>100 <500	>2,500 <5,000	>20 <40	>60 <100	>10 <50
Class 1	>10 <100	>1,000 <2,500	>10 <20	>30 <60	>5 <10

Trapezoidal Tear Strength and Tensile Strength

These tests use the same piece of equipment to measure the strength of the coverall in Newtons. In many work situations machinery is used and there is a risk that fabric may get caught in the machine. These tests give an indication of how strong the fabric is in case a situation arose where the coverall needed to be freed from the machine.

Coveralls can easily be torn if caught on sharp edges, for example, and so these are very real practical demonstrations of the strength of the fabric. The tests are very similar in that a sample of fabric is held in a clamp at the top and bottom, and the clamps are then pulled apart to see how much strength is required to pull the fabric apart.

In the **Trapezoidal Tear Strength** test (EN ISO 9073-4) a sample of fabric 150mm x 75mm is cut & marked out with lines indicating where the sample is to be clamped (Figure 1). A small cut 15mm is made through the center (Figure 2).

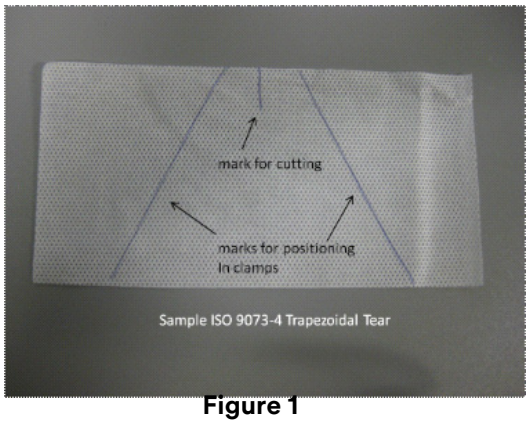


Figure 1

Figure 2

The sample is clamped in place along the non-parallel sides of the trapezoid with the cut half-way between the clamps. The clamps are pulled apart (Figure 3) until the fabric tears completely (Figure 4). But if the fabric has not completely pulled apart when the clamps are 64mm apart then at that point the mean strength is used for the result.

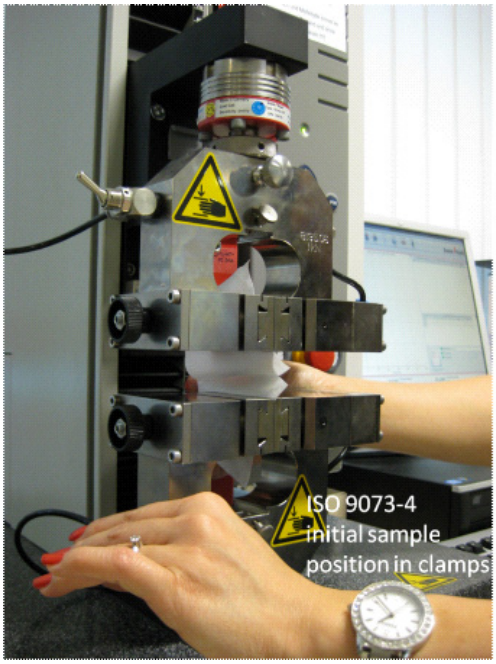


Figure 3

Figure 4

The **Tensile Strength** test – EN ISO 13934-1 - is very similar in principal but the size of the sample of fabric is 50mm x 250mm and no cut is made in the sample. As with the Trapezoidal Tear test this test is an assessment of the strength of the fabric.

Abrasive Resistance

This test (EN 530) looks at the durability of the fabric because in real work situations workers often rub against other surfaces e.g. by kneeling, or elbows on workbenches. This can be a problem because:

- Abrasion can create holes which can cause inward leakage.
- Abrasion can result in linting and in applications such as paint spraying or in the pharmaceutical industry where clean rooms are often used, lint can be a problem.

In this test 4 circular samples of fabric are cut with a diameter of 14cm. (Figure 5) Each sample is clamped onto the Martindale Abrasion machine and a downward pressure of 9kPa applied. The machine is set to carry out 10 rubs and the sample is then assessed. If there is no abrasion it is then set for a further 90 rubs i.e. 10 + 90 = 100 etc.

Classification is based on the lowest single result of the 4 samples that are tested.

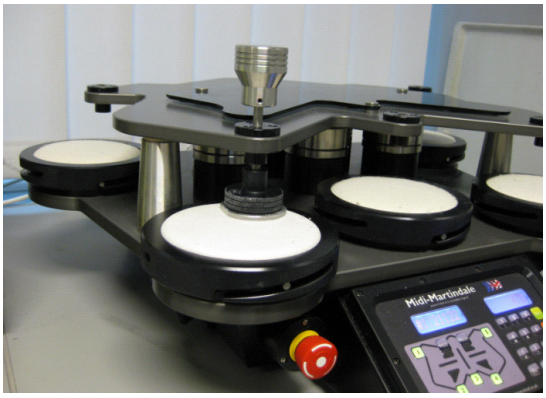


Figure 5

Flex Cracking

Measuring Flex Cracking is a way of assessing the flexibility of the fabric because in many industrial applications the work can be very physical and the coveralls need to be hard wearing. In work situations coveralls are worn for several hours at a time and during this time the fabric is flexed and creased many times through the natural movement of the wearer. It is important therefore to have a coverall made from a fabric that is not likely to crack and thereby create a weak point for penetration of potentially harmful dusts or liquids.

Figure 6

In this test samples of fabric 105mm x 50mm are clamped using metal cylinders at each end to make a roll. The center section of fabric is 36mm. The “roll” is then fixed to a machine which has a rigid bottom row and a moveable top row (Figure 6).

During the test this top row moves up and down which causes the fabric to flex and crease. The machine is set to carry out 1000 flexes & then the sample is assessed. If there are no cracks it is then set for a further 1500 flexes i.e. 1000 + 1500 = 2500 etc.

Puncture Resistance

In many work situations coveralls may be at risk from being torn or punctured by sharp edges or tools. It is therefore important to measure the Puncture resistance of the fabric to ensure it meets minimum requirements.

A sample of fabric is clamped between two 10mm thick metal plates. Each plate has a hole in the center through which a spike is advanced on to and through the sample of fabric at a rate of 100 mm/min. The maximum force needed to puncture the sample is recorded (Figure 7).

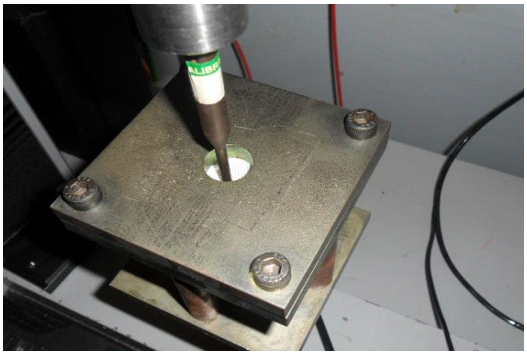


Figure 7

The range of 3M protective coveralls have been rigorously tested for both physical and chemical protective properties. The full suit tests ensure that the coverall will meet the requirements of the Standards to which the product has been certified. Furthermore, 3M protective coveralls are made to exacting specifications with rigorous Quality Control processes in place to ensure that product is made consistently to high standards.

The results of the tests can be found either on our Technical Data Sheets, on the User Instructions supplied with each product or by contacting your local 3M representative.

To find out more about the physical and chemical protective properties of the fabrics used in our products, or which 3M™ Protective Apparel solution best meets your needs visit www.3M.com/PPESafety or speak with your local 3M representative.

The use of the 3M product described within this document assumes that the user has previous experience of this type of product and that it will be used by a competent professional. Before any use of this product it is recommended to complete some trials to validate the performance of the product within its expected application.

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