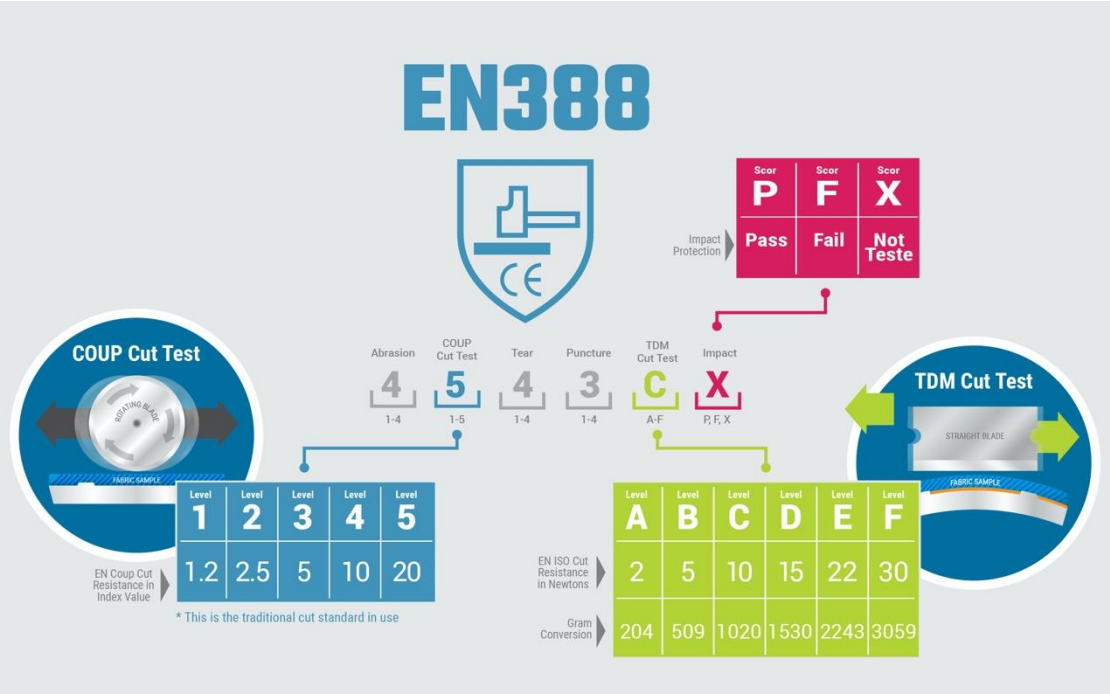
A Description of the EN388 test standards and a comparison to ANSI/ASTM test standards



	EN388 - Performance Levels					
Test Standard (paragraph #)	1	2	3	4	5	
6.1 Abrasion Resistance-# of cycles	≥ 100	≥ 500	≥ 2000	≥ 8000	NA	
6.2 Blade Cut Resistance - cut index Note: Circular Blade-Coupe test	1.2	2.5	5	10	20	
6.4 Tear Resistance-Newtons	≥ 10	≥ 25	≥ 50	≥ 70	NA	
6.5 Puncture Resistance-Newtons	10 - 20 N	20 - 60 N	60 - 100 N	100 - 150 N	NA	
6.3 TDM: Cut Resistance-Newtons Note: Straight Blade test	Level A ≥ 2 N	Level B ≥ 5 N	Level C ≥ 10 N	Level D ≥ 15 N	Level F ≥ 22 N	Level F ≥ 30 N

EN388, 6.1 – Abrasion resistance

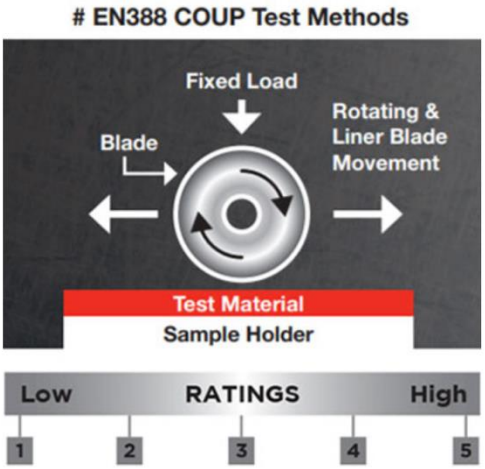
This test is carried out using an instrument known as a Martindale tester in which the material to be tested is placed on a bed and a rubbing head of fixed size and weight, covered with a standard abrasive material, is moved in a circular motion over the test specimen. Four samples of the material are tested, and the test result is the number of cycles required to rub through the material. The standard abrasive material used in this test is severe in action, it is unusual for textile materials to withstand the 2000 cycles required to meet performance level 3. The performance level of a single material is decided by the lowest result of the four tests.

Summary: Ability of the fabric, to withstand contact from an abrasive spinning disc. This test measures protection against abrasive surfaces, as well as demonstrating the durability and longevity of the fabric. RATINGS 1-4.

EN388, 6.2 –Coup Cut resistance

The instrument used for this test consists of a circular, free rotating blade, under pressure from a standard weight, which is moved backwards and forwards over the surface of the test material over a fixed stroke length. The test result is the number of cycles taken for the blade to cut through the material. To take the sharpness of the blade into account the test is performed using a standard material before and after testing the sample, the mean of these two tests on the standard material is defined as blade cut index 1. The test result is the ratio of the number of cycles required to cut through the sample to the number of cycles required to give blade cut index 1. Where multiple layer materials are involved the layers are assembled and tested as they would be in the garment. Two test samples are selected, each sample is tested five times and a mean blade cut index calculated from the five tests. The performance level is awarded in accordance with the lower mean blade cut index of the two samples.

Summary: Ability of the fabric, to withstand a cutting wheel slicing through after a number of cycles. This test measures the cut resistance of the material, which relates to the level of protection provided by the fabric. RATINGS 1-5.



EN388, 6.4 – Tear resistance

In this test a sample of fabric to be tested is prepared in a standard way and clamped in the jaws of a strength testing machine. The jaws are moved apart at constant speed and the force needed to tear the material measured. For single fabrics the performance level is given by the lowest result of four tests. The performance level is based on the lowest individual result of the most tear resistant material.

Summary: Ability of the fabric, to withstand force required to break the fabric in a stretch test. This test measures the strength of the fabric under stress. RATINGS 1-4.

EN388, 6.5 – Puncture resistance

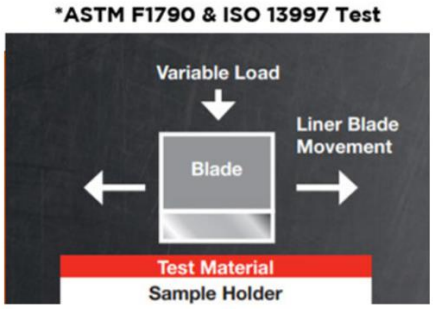
This test uses a standard, rounded point which is pushed through the material at a fixed speed and the force required for the point to penetrate through the material is measured. Where multiple layer materials are involved the layers are assembled and tested as they would be in the garment. Performance levels are awarded in accordance with the lowest of four test results.

Summary: Ability of the fabric, to withstand force from a sharp probe to break through. This test measures protection against puncture hazards, acting as a barrier of resistance against injury. RATINGS 1-4.

EN388, 6.3 – TDM Cut resistance

The test uses a straight blade drawn across a specimen until cut-through takes place – see figure, and measures the contact load applied to the blade in order to make a cut-through over a 20mm stroke length. Because the blade only travels once over the specimen and each blade is only used once, the problem of blunting blades with repeated cycles is eliminated. A number of tests are carried out with different contact loads applied to the blade. Force and cut-through length are plotted on a scatter graph and a trend line is generated. This is used to estimate the average contact force necessary to cut through the fabric with a 20mm stroke length. Once determined, the identified force is applied to the specimen a further five times. If the results of the stroke length are within the defined tolerance levels, the test is then complete, and the force has been determined. The performance levels range from 'level A' cut resistance with a contact force between 2N and 5N, up to 'level F', with a contact force greater than 30N, as shown in the table. There is no correlation between the levels of performance obtained through either cut method.

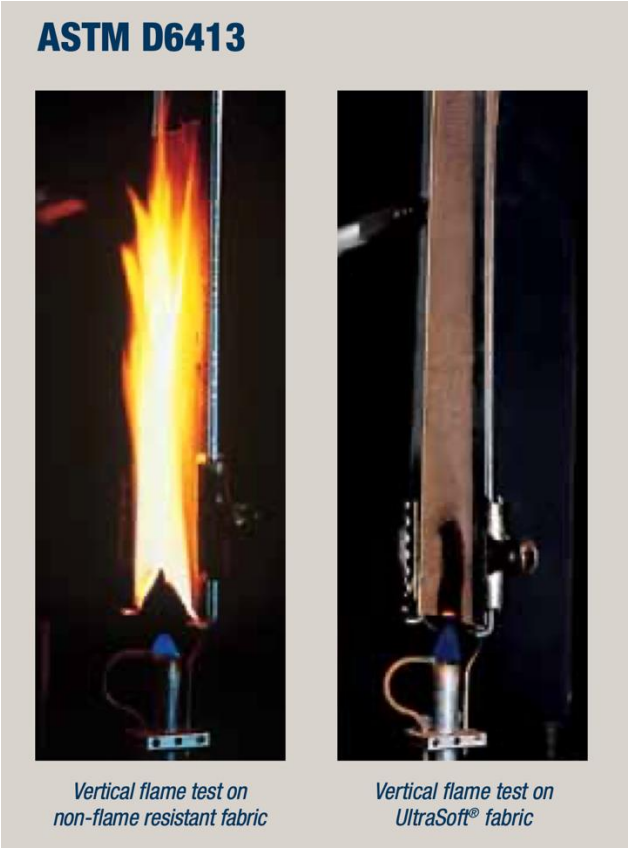
Summary: Ability of the material, to withstand a single motion cutting blade slicing through under force. This test also measures the cut resistance of the fabric material, without being impacted by the dulling blade effect of the Coup Cut test. This additional test (ISO 13997) also relates to the level of protection provided by the fabric. RATINGS A-F.



	EN388 2016 Standard Levels					
	LEVEL A	LEVEL B	LEVEL C	LEVEL D	LEVEL E	LEVEL F
Newtons	2	5	10	15	22	30
Gram Conv.	204	509	1020	1530	2243	3059

ASTM D6413 – Flame resistance

Flame resistance is the characteristic of a fabric that causes it to self-extinguish when the source of ignition is removed. The most commonly used test method is ASTM D6413 Standard Test Method for Flame Resistance of Textiles (Vertical Test). The vertical flame test is a test method with no pass/fail requirements. Industry- established standards range from 4” to 6” (100 mm to 150 mm) maximum char lengths. It is very important for flame resistant fabrics to self-extinguish. Fabrics that self-extinguish after the source of ignition is removed can dramatically reduce body burn percentage and increase the chance for survival.



ASTM F1358 – Flame resistance

This **test** method establishes a small-scale laboratory screening procedure for comparing the ignition resistance and burning characteristics of materials used in protective clothing where flame resistance is not the primary form of protection provided by the clothing. The vertical flame test is a test method with no pass/fail requirements. Industry- established standards range from 4” to 6” (100 mm to 150 mm) maximum char lengths. It is very important for flame resistant fabrics to self-extinguish. Fabrics that self-extinguish after the source of ignition is removed can dramatically reduce body burn percentage and increase the chance for survival.

Flame Resistance		
ASTM F1358-16		
Level	**Flame exposure(s)**	**After-Flame time(s)**
0	3	>2
1	3	<2
2	12	>2
3	12	<2
4	No ignition in either 3- or 12-second exposure period	

ASTM D3389/3884 – Abrasion

ABRASION

These ASTM test methods (D3389-10 and D3884-09) shall be followed using H-18 abrasion wheels with a 500 gram load for levels 0 to 3 and a 1000 gram load for levels 4 to 6. The test method has a 4-inch circular test specimen mounted on a horizontal axis platform while being abraded to failure under a specified vertical weight load (500 or 1000 grams) by the sliding rotation of two vertically oriented abrading wheels. The abrading wheels are comprised of vitrified clay and silicon carbide abrasive particles. The results, recorded in revolutions, are classified by ANSI/ISEA 105 Hand Selection Criteria as follows:

Taber Abrasion		
ASTM D3389-10, ASTM D3884-09		
Weight (Grams)	**Level**	**Revolutions**
500	0	<100
500	1	>100
500	2	>500
500	3	>1000
1000	4	>3000
1000	5	>10000
1000	6	>20000

ASTM F1790 – Coup Cut

The ANSI 105:2011 Standard specifies that gloves should be tested for cut resistance using the ASTM F1790-97 or ASTM F1790-05 test methods. In both of these methods, weight is applied to a straight edge razorblade, which is drawn back and forth across a swatch of the testing material. In the F1790-97 method, the razor blade travels 25 mm (1 in.), while in the F1790-05 method, the blade travels only 20 mm (.8 in.). The weight on the blade is gradually increased until the fabric breaks. The ANSI Cut Level for that material is determined by the weight on the blade at the moment the fabric breaks.

ANSI 105:2011 Standard

Cut Level	Weight needed to cut through material
0	< 200 g
1	⩾ 200 g
2	⩾ 500 g
3	⩾ 1000 g
4	⩾ 1500 g
5	⩾ 3500 g

Coup test

ASTM F2992 – TDM Cut

CUT

One of the major changes in this fourth edition of ANSI/ISEA 105 surrounds the determination of classification for cut resistance. The 2011 version allowed the choice of two different test methods (ASTM F1790-97, F1790-05) and two different test machines, the CPPT and/or the TDM.

To reduce variation for purposes of classifying a glove to this standard, a single test method (ASTM F2992-15 for TDM) has been selected in an effort to provide consistent meaning of the ratings from the end-user perspective. In addition, the number of classification levels has been expanded to address the disparate gap among certain levels seen in earlier versions and to model the approach used in similar international standards. ISEA and EN cut levels will be determined with the same piece of test equipment – the TDM – though the methods prescribed in each case (ASTM F2992 vs. ISO 13997) have slight differences.

NEW: ANSI/ISEA 2016		EUROPE: EN388-2016	
ASTM F2992-15 (TDM)		ISO 13997 (TDM)	
TDM ONLY		TDM ONLY	
LEVEL	GRAMS	LEVEL	NEWTONS*
A1	≥ 200	A	2
A2	≥ 500	B	5
A3	≥ 1000	C	10
A4	≥ 1500	D	15
A5	≥ 2200	E	22
A6	≥ 3000	F	30
A7	≥ 4000		
A8	≥ 5000		
A9	≥ 6000		

ANSI 105 – Puncture

PUNCTURE

The standard puncture test remains the same, using the EN388 puncture probe. An additional update is the inclusion of a needlestick puncture test, recognizing that this is a common potential exposure for the medical, sanitation and recycling industries.

As seen at right in the photo, the standard EN388 probe is very large. There is a segment of users who need protection from smaller hypodermic needles, requiring a significantly different puncture device – very thin and very sharp – and calling for using a new testing method and rating scale. The new method uses a 25-gauge needle as a probe, pictured at left.

The normal industrial puncture test is done in accordance with clause 6.4 of EN 388:2003 (updated in 2016). A circular test specimen cut from the glove palm is mounted in a holder and punctured with a stylus of specified sharpness attached to a tensile tester. The force required to puncture the specimen to failure is measured. Results are classified into five performance levels; the higher the result, the better the performance. The average of 12 specimens (minimum) shall be used to determine the classification level.

Puncture Resistance Levels

Level ANSI 105:2011	EN 388:2003
0	< 10 N < 20 N
1	⩾10 N ⩾ 20 N
2	⩾ 20 N ⩾ 60 N
3	⩾ 60 N ⩾ 100 N
4	⩾ 100 N ⩾ 150 N
5	⩾ 150 N n/a

A Comparison of EN388 to ANSI/ASTM Standards

(Single Layer and Double Layer SWX Fabric)

	Performance Levels					
Test Standard	**1**	**2**	**3**	**4**	**5**	
EN388 6.1 Abrasion Resistance-# of cycles	≥ 100	≥ 500	≥ 2000	≥ 8000	NA	
Single Layer		**2**				
Double Layer			**3**			
ANSI 105: ASTM D3389/3884	≥ 100	≥ 500	≥ 1000	≥ 3000	≥ 10000	
Single Layer		**2**				
Double Layer			**3**			
EN388 6.2 Blade Cut Resistance - cut index; Note: Circular Blade-Coupe test	1.2	2.5	5	10	20	
Single Layer		**2**				
Double Layer					**5**	
ANSI 105: ASTM F1790	≥ 200g	≥ 500g	≥ 1000g	≥ 1500g	≥ 3500g	
Single Layer	This standard does not translate to an EN388 standard					
Double Layer	This standard does not translate to an EN388 standard					
EN388 6.4 Tear Resistance - Newtons	≥ 10	≥ 25	≥ 50	≥ 70	NA	
Single Layer				**4**		
Double Layer				**4**		
ASTM D5034 / D5035	≥ 10	≥ 25	≥ 50	≥ 70	NA	
Single Layer				**4**		
Double Layer				**4**		
EN388 6.5 Puncture Resistance-Newtons	10 - 20 N	20 - 60 N	60 - 100 N	100 - 150 N	NA	
Single Layer			**3+**			
Double Layer				**4**		
ANSI 105: Same as EN388 6.5	10 - 20 N	20 - 60 N	60 - 100 N	100 - 150 N	≥ 150 N	
Single Layer						
Double Layer			**3+**		**5**	
EN388 6.3 TDM: Cut Resistance-Newtons; Note: Straight Blade test	Level A ≥ 2 N	Level B ≥ 5 N	Level C ≥ 10 N	Level D ≥ 15 N	Level F ≥ 22 N	Level F ≥ 30 N
Single Layer		**B**				
Double Layer				**D**		
ANSI105: ASTM F2992 - Grams	A1 ≥ 200 g	A2 ≥ 500 g	A3 ≥ 1000 g	A4 ≥ 1500 g	A5 ≥ 2200 g	A6 ≥ 3000 g
Single Layer		**A2**				
Double Layer				**A4**		