DUPONT™ KEVLAR®

The science of cut protection.

Understanding cut protection performance—it's not as easy as 1, 2, 3

When it comes to specifying protective gloves, there are many things to consider, including: the hazards of the job, dexterity requirements, durability, grip, comfort and value-in-use. Using published data, it is relatively easy to compare the performance of various commercially available gloves for most of these considerations.

Unfortunately, one of the most important considerations—cut resistance—is often the most difficult to compare. It's not for a lack of published data but rather the confusion surrounding the different standards and methods that are used globally to measure it.

Simply stated, even though the performance level rating may be the same, different standards mean different performance at the same "level." Make sure you have the information you need to make an informed decision.

Consider the keys to cut protection

The first thing to remember is that cut protection is a combination of factors, not just the material of construction. When assessing the cut-resistant properties of a glove, you must consider several keys to cut protection, including: material of construction, basis weight, fabric construction and coatings.

Of these factors, the material of construction—such as DuPont™ Kevlar® fiber, high molecular weight polyethylene, leather, cotton, steel, etc.—has the greatest impact on the cut resistance of personal protective equipment (PPE).

Comparing cut-resistant values

When making direct comparisons between different finished products, it is essential to know which test method—and which cut tester—was used. In addition, the basis weight of each sample and the fabric construction must be the same to make a head-to-head comparison.

Why? The higher the basis weight, the higher the cut resistance because there is more material present. And, the details of the fabric construction (type of knit or weave and threads/stitches per inch) can affect yarn mobility and sample thickness, which can also affect cut resistance.

Ideally, the samples should be tested in the same laboratory to obtain the most accurate comparison.

Hand protection performance standards

Standards specify test methods and focus on levels, not the measured property. Two hand protection performance standards are widely used: the American National Standards Institute/International Safety Equipment Association (ANSI/ISEA) 105 "American National Standard for Hand Protection" and the European standard EN 388 "Protective Gloves Against Mechanical Risks."

ANSI/ISEA 105 defines levels for the mechanical, thermal, chemical and dexterity performance of hand and arm PPE. Performance levels for cut resistance are specified in this standard (refer to Table I).

Table I. Classification for Cut Resistance Level Weight

Performance level	Weight (grams) needed to cut through material 25 mm (1.0 in.) of blade travel–ASTM F1790-97 20 mm (0.8 in.) of blade travel–ASTM F1790-05
0	< 200
1	≥ 200
2	≥ 500
3	≥ 1000
4	≥ 1500
5	≥ 3500

Although a European norm, EN 388 is recognized globally and many PPE manufacturers refer to the EN 388 performance levels on their product packaging, in their literature and on their websites. This is a major source of confusion for many people because EN 388 uses different level groupings (refer to Table II) and a completely different method of testing than ANSI/ISEA 105.

Table II. EN 388 performance levels for cut resistance

Performance level	Blade cut resistance (cut index)
1	1.2-2.4
2	2.5-4.9
3	5.0-9.9
4	10.0-19.9
5	20+

Because of these differences, EN 388 and ANSI/ISEA 105 cut levels are not interchangeable.

A closer look at ANSI/ISEA 105

Some PPE manufacturers will refer to the ANSI/ISEA 105 performance level category for the cut resistance of their product instead of the absolute value. Although this is an acceptable practice, it does not provide complete information to adequately compare the performance of different products.

That's because products classified within the same performance level are not necessarily equal. Levels can span a wide range of performance values.

Although level ratings give a good idea of the general performance of a glove or sleeve, the actual cut performance values should be used when comparing products, particularly if they fall into the same or adjacent performance levels.

The ANSI/ISEA 105 cut performance levels are based on values obtained using the ASTM F1790 method. The latest ASTM standard for measuring cut resistance is the 2005 method (ASTM F1790-05). This method covers both CPP and TDM testers.

When using a CPP tester, cut resistance values obtained for ASTM F1790-05 are typically lower than the values obtained for the same sample using the 1997 version. This is primarily because the 2005 method does not require the blade to cut through the mounting tape to register a cut result.

A provision was made to allow use of the 1997 method for the CPP tester because of the lower cut values relative to the TDM tester when using the 2005 method. Another consideration is the large amount of historical data based on the 1997 procedure.

Methods for testing cut resistance

There are three standardized methods for testing cut resistance: ASTM F1790 (U.S.), ISO 13997 (International) and EN 388 (Europe). Three types of cut testing equipment are used to support these standards. The TDM tester can be used for each of these methods. ASTM F1790 also allows the use of the CPP tester and EN 388 allows the use of the Couptest tester.

In the ASTM F1790 and ISO 13997 test methods, the sample is cut by a straight-edge blade, under load, that moves along a straight path. The sample is cut five times each at three different loads and the data is used to determine the required load to cut through the sample at a reference distance of 25 mm (1.0 in.) or 20 mm (0.8 in.).

In the EN 388 test method, a circular blade, under a fixed load, moves back and forth across the sample until cut-through is achieved. A cotton canvas fabric is used as the reference material. The reference material and test sample are cut alternately until at least five results are obtained. The cut resistance is a ratio of the number of cycles needed to cut through the test sample vs. the reference material.

ASTM F1790-97 vs. ASTM F1790-05

The active ASTM standards for measuring cut resistance are the 2005 method (ASTM F1790-05) and ASTM F1790-97, the original ASTM F1790 standard.

The major differences between the 1997 and 2005 versions are: only the CPP tester could be used in the original version; there is no cut through the mounting tape to register a result; the reference difference was decreased from 25 mm (1.0 in.) to 20 mm (0.8 in.); the calibration load was increased to 500 g; and calibration distances are specified for the CPP tester and TDM tester.

The impact of these changes further complicates the process of making accurate comparisons between various products. Described earlier, when using a CPP tester, cut resistance values obtained using ASTM F1790-05 are typically lower than the values obtained for the same sample using ASTM F1790-97. This is primarily because the 2005 method does not require the blade to cut through the mounting tape to register a result.

DuPont supports standards

The latest effort by DuPont is a commitment to championing the use of ASTM and ISO cut protection standards. As the manufacturer of Kevlar® fiber, which has earned a reputation as a gold standard in cut protection, DuPont is working closely with glove manufacturers to help them improve the end-user selection process.

One of the most important steps in this process is a new, global naming standard that was introduced in 2012. As shown in Table III, this new standard is directly tied to both ASTM and ISO standards to make it easier to find the appropriate level of protection and a suitable glove for the task at hand.

Table III. New naming standard for DuPont™ Kevlar® fiber tied to ASTM and ISO standards

Finished glove cut performance		Brand name
CPP machine (g)*	**TDM machine (g)****	
500–999	500–949	Made with Kevlar® 500
1,000–1,499	950–1,399	Made with Kevlar® 1000
1,500–2,199	1,400–2,099	Made with Kevlar® 1500
2,200–2,999	2,100–2,799	Made with Kevlar® 2200
3,000–3,999	2,800–3,699	Made with Kevlar® 3000
4,000–4,999	3,700–4,599	Made with Kevlar® 4000
5,000+	4,600+	Made with Kevlar® 5000

*Use ASTM 1790-97 method.
**Use 1790-05 or ISO 13997 method. For reinforced materials (steel, glass and other), false cuts and high variability in cut readings may be an issue; use of insulating material may be required. If used, note material and type. Suitable insulation can be obtained by using double-sided tape (PolyKen Tyco 2” x 36 yards, which is the same material used in ASTM 1790-97) or by leaving the copper-strip backing in place (RGI part #2147 3/8” wide copper strip).

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Summary

Industry standards groups have made tremendous progress in testing and measuring the cut protection performance of gloves and apparel. It is now commonplace to have a wide range of performance data available for protective apparel.

Although the availability of cut protection performance information is widespread, it is important to understand the different test methodologies in order to interpret the data and draw accurate conclusions.

Specifiers will benefit by taking the time to better understand the sources of information and the critical factors that influence cut protection because it's not as easy as 1, 2, 3.

The miracles of science™

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