What you need to know about changes to the EN388 standard for protective gloves

A new revision to the EN388 standard for gloves giving protection from mechanical risks, including cuts, will increase the accuracy and reliability of cutting tests on materials with higher cut resistance. Critically, it will lead to a clearer understanding of the true cut resistance of protective gloves.

EN388 describes the test methods and requirements for classifying protective gloves according to their resistance to abrasion, cutting, tearing and puncturing. It is the de facto standard in most parts of the world. Since its last revision in 2003, new high performance fibers designed specifically for cut-resistant gloves have created a strong need for modification to the existing cut level test, in order to accurately measure the increased safety level that the gloves can provide.

The new revision, which is expected to come into effect in the second quarter of 2016, has been welcomed by DSM Dyneema, the producer of Dyneema® ultra-high molecular weight polyethylene fiber used in many of the most cut-resistant and comfortable protective gloves on the market. DSM Dyneema has built up considerable experience and applications know-how relating to high performance cut-resistant gloves, and believes that EN388 2016 will help glove specifiers and users choose the products best suited for their needs. DSM Dyneema is an active member of the Technical Committee charged with revising EN388.

It has taken a long time to bring about this important revision, but DSM Dyneema expects there to be a good deal of confusion in the market about the changes being implemented to the cutting tests, and the implications of these changes for producers along the value chain, for buyers and for end-users. In this document, we set out to clarify the situation.

How is cut resistance determined today?

In its present form, EN388 designates the Coup Test method for assessing the cut resistance of all types of gloves giving protection from mechanical risks. In this test, a rotating circular blade, similar to a pizza cutter, moves back and forth across a sample of the glove material laid on a flat hard surface, under a fixed load of 5 N, until it cuts through it. The cut resistance of the test fabric is compared to the resistance of a reference cotton fabric, and the ratio between the two is known as the Cut Index. Based on this index (averaged over several tests), gloves are given a Cut Level number between 0 and 5, with 5 indicating the highest resistance under this particular test method. A schematic of the test and a table showing the relationship between average Cut Index and Cut Level is provided in the following illustration.
Why is the revision necessary?
The Coup Test runs into problems when testing materials such as high performance fabrics based on Dyneema® Diamond Technology fiber, as well as other materials such as glass fiber and stainless steel, all of which have a dulling effect on the blade. As a consequence of this dulling, the test can yield an inconsistent and inaccurate result, providing a Cut Level that is not truly indicative of the real cut resistance of the material (in some situations it is too high, in others it is too low).

For materials that are shown to dull the blade during an initial test sequence in the Coup Test, the 2016 edition of EN388 will state that the gloves must be tested using a different procedure, known as the TDM Test or ISO Cut Test, which is already specified in the international standard EN ISO13997. (The current version of EN388 does in fact already specify both the Coup Test and the TDM test described in EN ISO13997, but the latter is only included as a voluntary “to be validated” test to supplement the Coup Test.)

Furthermore, for all Coup Tests, independent of the cut resistance of the test material, the blade will have to be changed after five test sequences and the test will have to be stopped after 60 cycles on the test specimen, even if the blade has not cut through the material.

How is dulling defined?
In the Coup Test method, the sharpness of the blade is calibrated on a cotton canvas material. This is usually given a value of 1, which represents 1 single back-and-forth movement (should be between 0.8 and 1.4 at the first cut sequence and between 0.8 and 2 at every 4 other consecutive cut sequences), indicating that the circular blade can travel back and forth on the cotton canvas once before cutting through. After this calibration, specimens of the material to be assessed are tested. The cotton canvas reference material is then tested again, in order to establish if the sharpness of the blade has changed: if the blade still cuts through the reference material after the single back-and-forth movement, the sharpness of the blade is considered to have not changed.

### Performance Level vs. Average Cut Index

<table>
<thead>
<tr>
<th>Performance Level</th>
<th>Average Cut Index</th>
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<tbody>
<tr>
<td>0</td>
<td>&lt; 1.2</td>
</tr>
<tr>
<td>1</td>
<td>1.2 – 2.4</td>
</tr>
<tr>
<td>2</td>
<td>2.5 – 4.9</td>
</tr>
<tr>
<td>3</td>
<td>5.0 – 9.9</td>
</tr>
<tr>
<td>4</td>
<td>10.0 – 19.9</td>
</tr>
<tr>
<td>5</td>
<td>≥ 20</td>
</tr>
</tbody>
</table>
If it takes more than three back-and-forth passages to cut through, the blade is considered to have “dulled”. At this point, under the 2016 version of EN388, the ISO Cut Test must be used to test the sample, although the Coup test can still continue to be used and reported on a voluntary base. As already noted, this usually happens when materials containing glass fiber, stainless steel or Dyneema® Diamond Technology are being tested.

Why stop after 60 cycles with highly resistant gloves?
As previously indicated, under EN388 2016, if the Coup Test blade fails to cut through the test material even after 60 cycles, the test will have to be stopped. When testing highly cut-resistant materials, the circular blade would otherwise be considered dull at this point, and any result would have little or no relevance.

In the most unlikely case that, after these 60 cycles and a re-test on the reference cotton fabric, no dulling is perceived, the material will be given a Level 5 classification. But if the blade is seen to have dulled—by far the most likely outcome—the Coup Test is deemed irrelevant and the ISO Cut Test has to be used as the reference.

The final Cut Level according to the Coup Test can still be shown on the glove label showing the EN388 symbol, but in reality it is very unlikely that any glove will achieve Cut Level 5. With current materials, it is virtually impossible for a blade that fails to cut through a test material after 60 cycles not to have dulled significantly—rendering the result of the Coup Test meaningless.

The following graphics and table illustrate the likely difference in results obtained when testing a high dulling material under the current version of EN388 and the 2016 version of EN388 (the numbers for T, C1 and C2 refer to the number of times the blade passes over the test piece (T) and the cotton reference during calibration (C1) and after the test (C2). Values are averages of five measurements.
With any value of \( C_n \) over 3.0, and the number of test cycles limited to 60 in EN388:2016, the maximum Cut Level achievable is 4. This is essentially always the case with dulling materials such as glass fiber, steel and Dyneema® Diamond Technology.

How does the ISO Cut Test work?

The TDM cut test according EN ISO 13997 has a completely different cutting mechanism from the Coup Test, and the results it provides are also very different. Instead of a Cut Index and a numeric Cut Level, this test yields a value in Newtons (referring to the force of the blade on the sample), which is represented in the classification of the glove by a letter from A to F.

This test is designed to better simulate an accidental cut or slash with a sharp object. Scores that gloves achieve should therefore be more indicative than those achieved with the Coup Test of performance in real-life situations. Furthermore, results obtained with the ISO Cut Test for highly cut resistant materials are more consistent and less dependent on the testing laboratory—and so more reliable.
The test, which is comparable with the one described in the ASTM standard F1790 adopted in North America, uses a flat cutting blade that is pressed by a known load into the test fabric laid over a slightly curved hard surface, and then slid over it. The sliding stops when the blade cuts through the material (as is also the case with the Coup Test, this point is established when the blade contacts a foil of aluminum in the hard surface, completing an electric circuit).

Different loads are provided to push the fabric and blade together, resulting in different traveling distances of the blade before it cuts through the fabric. Obviously, the higher the load, the shorter the distance travelled by the blade. For standardization purposes, it was decided to use the force that enables the blade to cut through the test piece after a stroke of 20 mm.

The following illustrations show how the test works and what results it provides.

1) Photo on the left shows a TDM-100 machine suitable for carrying out the cut test according EN ISO13997. The weights that can be changed to modify the force applied to the blade, as well as the blade itself as it cuts through a test piece mounted on a curved surface, are highlighted.

2) Schematic of the cutting mechanism - applying a certain load onto a sharp blade that travels over a test sample. The substrate under the test sample is a conductive strip, so that when the blade cuts through the fabric it completes an electric circuit that is detected by the test equipment controller.
3) After various tests with different loads have been carried out, a graph can be produced to describe the ratio of load applied to the cutting knife and the distance it has travelled when it cuts through the sample. The value that determines the Cut Level is defined as that required for the blade to cut through the material after travelling 20 mm. The graph below shows results from tests on a material for which a force of 13.04 N was required for the blade to cut through it.
The following table shows the classification of cut resistance according to the ISO Cut Test, indicating the cutting force associated with each letter.

<table>
<thead>
<tr>
<th>Level</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISO Cut Test (N)</td>
<td>≥2</td>
<td>≥5</td>
<td>≥10</td>
<td>≥15</td>
<td>≥22</td>
<td>≥30</td>
</tr>
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How will I be able to choose the right glove for my needs?
The EN388 pictogram on glove labelling will make it fully clear as to which cut resistance test has been used to classify the glove. Next to the number from 0 to 5 obtained from the Coup test, there will be a letter from A to F showing the value obtained from the ISO Cut Test.

DSM Dyneema expects that once EN388 2016 is fully implemented, the cut-resistant market will roughly fall into the following segments according to cut performance:

- A: multipurpose gloves;
- B / C: most common applications in industries requiring medium cut resistance (metal and glass processing for example);
- D: gloves suitable for applications where high cut resistance is required;
- E / F: very specific, very high risk and high exposure applications (in the meat processing industry for example) that demand ultra-high cut resistance.

Judging by DSM Dyneema’s experience, most of today’s cut resistant gloves will perform at the B or C level. As far as Dyneema® Diamond Technology materials are concerned, the following summary can be made:

- 18-gauge gloves based on a 220dtex Dyneema® Diamond Technology will perform in most cases as a Level B;
- 15-gauge gloves based on a 440dtex Dyneema® Diamond Technology will perform in most cases as a Level C;
- 13-gauge gloves based on a 660dtex Dyneema® Diamond Technology will perform in most cases as a Level D.

When should each test be used?
For the measurement of gloves with non-dulling materials — typically nylon, cotton, leather and Dyneema® (but NOT Dyneema® Diamond Technology)—the Coup Test remains the mandatory standard; the value under the ISO Cut Test can be obtained and used voluntarily (otherwise an X for “not applicable” will be displayed on the EN388 pictogram). So, for example, a standard glove based on regular Dyneema® will very likely be classified as EN388 4343X (or optionally EN388 4343B).
DSM recommends that the ISO Cut Test is always used, even for materials not containing dulling materials, and that the new letter-based rating is displayed on the label. End users will demand clarity and uniformity when assessing the performance levels of gloves, and it is expected that the A-F rating will become their new reference. Furthermore, DSM Dyneema expects the principle of the ISO Cut Test method to rapidly become a global reference for measuring cut resistance.

For the measurement of gloves made with dulling materials - typically glass fiber, stainless steel or Dyneema® Diamond Technology—the ISO Cut Test will be mandatory and the Coup Test voluntary (otherwise an X for “not applicable” will be printed under the EN388 logo). So, for example, a glove based on Dyneema® Diamond Technology 440dtex will very likely be classified as EN388 4X43C (or optional EN388 4443C).

DSM recommends the use of an X rather than a digit with reference to the Coup Test for these types of gloves, as shown in the following illustration. Continued publication of the numeric scores may confuse end users and possibly provide them with inaccurate information regarding the performance of the glove.

When will the change be implemented?
At the time of writing, the exact date when the new EN388 will become active is still pending. The new standard, incorporating the proposals on changes, is currently being translated prior to submission for formal approval throughout the European Union. Once approved, the European Committee for Standardization (CEN) will make a proposal to the EU Commission to harmonize the standard and have it published in the Official Journal of the European Union. The revised EN388 will become the valid standard following the official publishing date, although compliance to the old standard will remain valid as long as existing CE type examination certificates have not expired. The revised standard will probably come into force during the second quarter of 2016. As long as the new standard is not harmonized in the Official Journal of European Union, the existing standard remains valid.
It is DSM Dyneema’s view that the glove industry has an obligation to provide end users with the most accurate information possible about glove safety; it therefore recommends that labels be changed to reflect information from the revised standard as soon as it is implemented.

**Dyneema® Diamond Technology offers protection AND comfort**

The changes to EN388 will serve to highlight the outstanding protection provided by cut-resistant gloves based on Dyneema® Diamond Technology. Because of the dulling effect on the blade, it will no longer be possible to use only the Coup Test on gloves in Dyneema® Diamond Technology, as well as gloves made in glass fiber and stainless steel. This is a reflection of the very high level of cut protection that Dyneema® Diamond Technology can give. What sets Dyneema® Diamond Technology apart from those alternatives is the excellent flexibility of the fiber and the higher comfort it provides alongside the high and consistent protection for the user. Even the lightest and most comfortable gloves in Dyneema® Diamond Technology provide excellent cut resistance.

Glove users generally need to make the trade-off between the risk in the application and the level of comfort they are looking for. Gloves with high cut scores typically provide lower levels of comfort and dexterity than gloves with less cut resistance. Comfort is king, and is arguably the biggest factor in ensuring that workers continue to wear the protective gear with which they are issued. Bulky gloves that restrict the free motion of hands and fingers are no longer effective or appropriate.

This is where gloves incorporating Dyneema® Diamond Technology truly stand out. They provide excellent cut resistance AND high levels of comfort and dexterity.

**Summary**

A revision of the EN388 standard for gloves giving protection from mechanical risks (including cut-resistant gloves) will be published during 2016. It will incorporate modifications to the current Coup Test, and it will mandate the use of the ISO Cut Test for gloves made in highly resistant materials for which the Coup Test does not provide an accurate result. As a result of these changes, EN388 will provide a more accurate indication of the level of protection provided by all types of gloves, whether they have high or low cut resistance.

Labelling on gloves will provide extra clarity about which cut test (or tests) has been used to test the glove. Glove users will therefore be in a better position to judge which is the right glove for their purposes.

EN388 2016 will provide an extra demonstration that cut-resistant gloves incorporating Dyneema® Diamond Technology provide the highest level of cut protection currently available. These gloves have the additional and important advantage that they are very comfortable to wear.
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