



Permethrin Treated Clothes - Material with Anti-insect Treatment

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Estonian
Defence Industry
Association

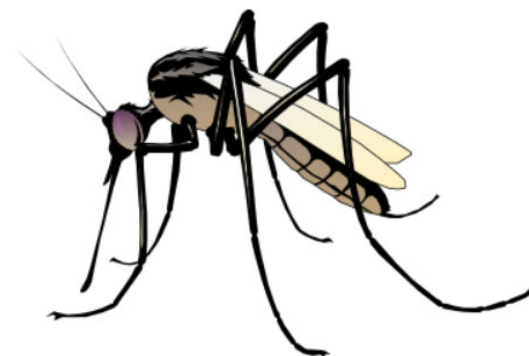
- ▶ Proflin is a member of Estonian Defence Industry Association (EDIA)
- ▶ Work in clothing and special equipment group
- ▶ Since 2017 development of combat clothing with anti-insect treatment



Goal: develop a prototype, fabric 50/50
nylon/cotton digi-camuoflage, anti-insect
treatment, effective for at least 150 laundry

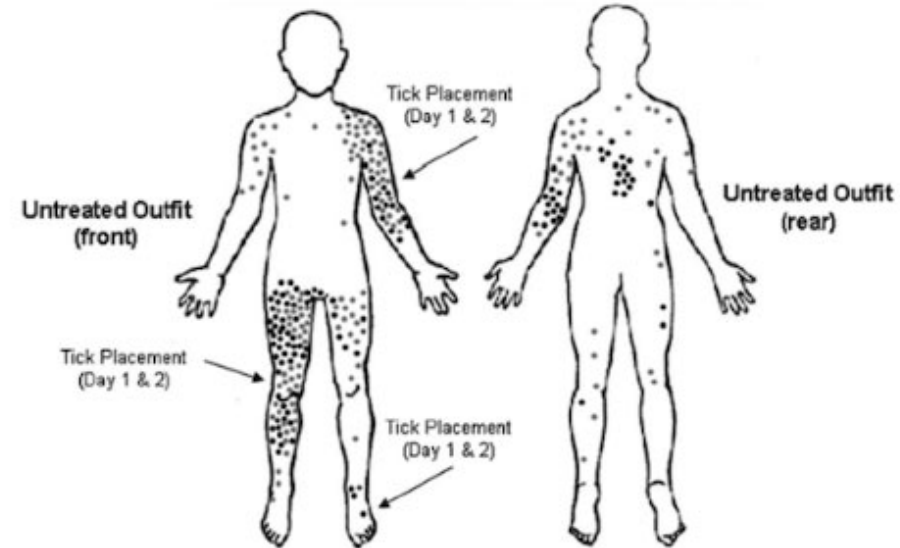
Needs to be tested:

- ▶ if mechanical characteristics, promised by manufacturer, are really valid
- ▶ if really works in a field
- ▶ how treatment affects on customers health
- ▶ how presistant is treatment in everyday use during 3 years
- ▶ how affects on fabrics characteristics, e.g. breathability



- ▶ Soldiers, health-workers, policemen and other people who are frequently exposed to vectors during missions in hot and tropical conditions, are recommended to use a combination of a DEET-based creme, to protect exposed body parts i.e. hands and face, and permethrin treated garments. **When applied correctly, the protection factor is > 95 percent**

- ▶ Ticks transmit more cases of human disease than any other vector arthropods in Europe and North-America. Lyme Borreliosis in particular is the most commonly reported. **Wearing garments which have been correctly factory treated with permethrin can offer a protection rate of 95,65 %**



US National pesticide information center:

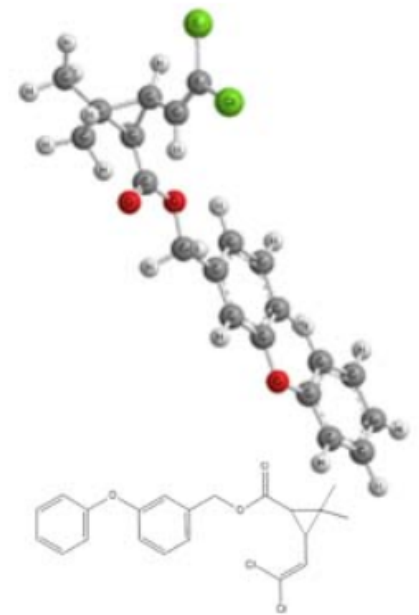
- ▶ Clothing, shoes, bed nets, and camping gear can be treated with a pesticide called permethrin to kill or repel insects such as mosquitoes and ticks. Clothing and other products can be purchased pre-treated, or products can be treated using EPA-registered products. **The U.S. Military has been using permethrin to treat combat uniforms for over 20 years to protect soldiers from diseases carried by insects.**
- ▶ Permethrin is the **only pesticide approved by the EPA** (Environmental Protection Agency) **for these uses**. When it is applied properly, permethrin binds tightly to the fabrics, resulting in little loss during washing and minimal transfer to the skin. Permethrin is poorly absorbed through the skin, although sunscreens and other products may increase the rate of skin absorption.



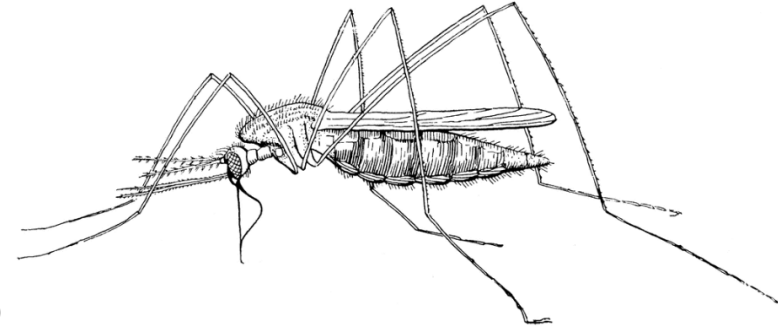
How Does Permethrin Work?

- ▶ Permethrin is a synthetic version of a chemical produced naturally by the **chrysanthemum** flower. It's often called a repellent, but works more like an insecticide. That is, it doesn't stop bites primarily by preventing mosquitoes from landing on you but by **incapacitating** or **killing the insects** after they land and – hopefully - before they bite.

Molecular Structure -
Permethrin



Permethrin - medication and insecticide



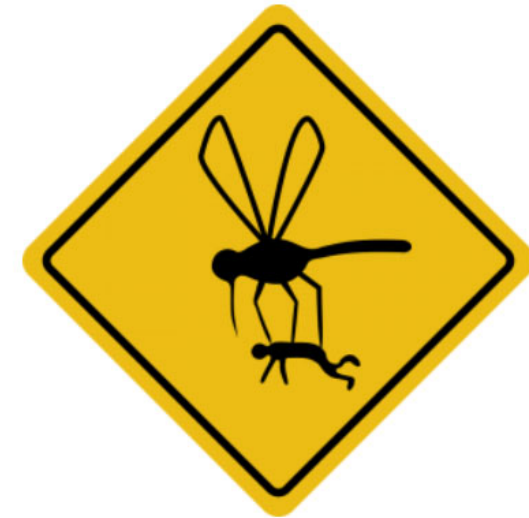
- ▶ As a medication is used to treat scabies and lice
- ▶ As an insecticide can be sprayed on clothing or mosquito insects that touch them
- ▶ It works by disrupting the function of the neurons of insects
- ▶ Was first made in 1973. It is on the World Health Organization's List of Essential Medicines, the **most effective and safe** medicines needed in a health system
- ▶ Permethrin kills ticks and mosquitoes on contact with treated clothing
- ▶ To better protect soldiers from the risk and annoyance of biting insects, the US and British armies are treating all new uniforms with permethrin.
- ▶ Permethrin has little effect on dogs; however, it is toxic to cats

From Pesticide Properties DataBase:

Permethrin is a contact insecticide that is not approved for use in the EU. It is not highly soluble in water, has a low volatility and is not normally expected to leach to groundwater. It would also not be expected to persist in soil or water systems. It is moderately toxic to humans, is an irritant and may be a CNS toxicant. It is highly toxic to most aquatic species and honey bees but is not highly toxic to birds or earthworms.



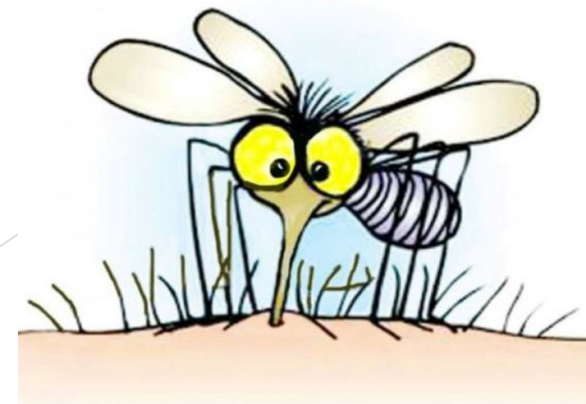
In an age when vector-borne diseases are emerging or resurging worldwide, personal protective measures are essential for shielding soldiers and other exposed personnel from arthropod attack, especially during deployments in disease-endemic countries. A central focus of personal protection is the use of permethrin-impregnated BDUs. A new polymer-coating technique for the treatment of BDUs has recently been introduced by some NATO- member nations. This technique has been shown to provide residual protection against the entire spectrum of disease-carrying arthropods for the life of the uniform. **Polymer coating is also safe and inexpensive**, and because the process is completed at the factory, it minimizes logistical problems. Commanders and military medical specialists need only ensure that polymer-coated uniforms are available to their deployed personnel and that such uniforms are properly laundered, thus prolonging their efficacy in force health protection.



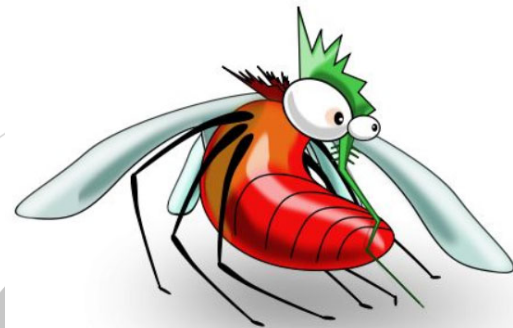
- ▶ The old system of „dipping“ or „spraying“ the garments with a permethrin solution has been replaced by a more efficient and above all more ecological and safer alternative: **the factory-based impregnation of the fabric.**
- ▶ This has been introduced in the late nineties in Europa and has since then constantly been improved and fine-tuned.
- ▶ This application is photo-stable, resists well to weathering, has low mammalian toxicity and offers logistic advantages.
- ▶ The finish should preferably be applied to fabric which contain a majority of **cellulosic fibers** (Cotton, Wool, Lenzing FR, ...). Aramid blends can also be treated, in plain as well as in **camouflage prints.**
- ▶ Combinations with a water-repellent finish are possible, but need to be developed individually.
- ▶ Some military users: France, Germany, Sweden, Norway, Finland, Belgium, Hungary, Luxemburg, Austria, ...



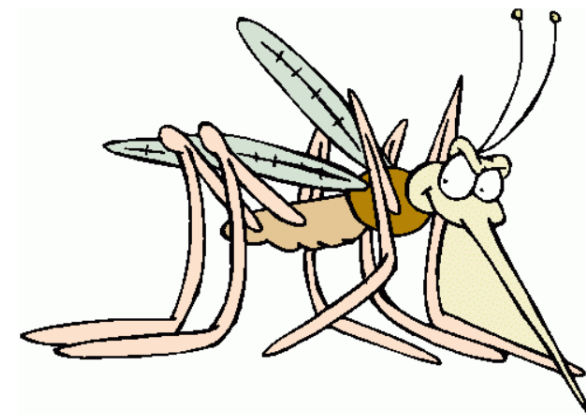
- ▶ In order to assure that the **manufacturer complies fully to all aspects** of the TL8305-331/4, the WIWeb issues **certificates**, after having screened the product and the production facility, to make sure the **critical quality levels** are kept. Consequently, these fabrics can only be made by approved suppliers. (see annex 7)
- ▶ The final result + well-controlled health-risk for the wearer is only guaranteed if the active ingredient (permethrine) is **perfectly embedded** in polymer-matrix, which releases the biocide in a slow and controlled manner.
- ▶ Permethrin, once applied to textiles, is subject to dermal absorption. The permethrin has a transient storage in the epidermis, and is slowly distributed through the body and **metabolized** via various routes (urine, faeces).
- ▶ When applied correctly, combining 27-75 Cis/trans permethrine with copolymers (acrylic + silicone-elastomers), the absorption is 5-6 microgram/kg bodyweight, which is 5 times BELOW the ADI-level (see annex 2-4)



- ▶ Permethrin is normally **not considered** as having a great effect on the human skin although sometimes **rash and irritation** was noted. In this respect, the vitro test with a mouse (L929), as done e.g. by Hohenstein labs in Germany, which analyses cytotoxic substances is not sufficiently reliable.
- ▶ Therefore, the Bundeswehr commissioned an extensive study into the dermal absorption of permethrin in soldiers wearing BDU, both in Germany and Afghanistan (see annex 2, 4).
- ▶ Depending on the formulation and impregnation technique used, binding parameters, bioavailability and bioactivities may differ significantly and consequently also wearer's exposure to permethrin.



- ▶ When applied correctly, the system using Permethrin+Acrylic+Silicone-elastomers will cause virtually no cross-contamination during the washing process. This means that garments which are not treated with permethrine **can be washed together** with treated ones. This specific way of binding the permethrin to fabric reduces the cross-contamination from 15-50 percent (IARFT-system) to only 3-5 percent (Copolymer-system)
- ▶ The small amount of permethrin which is released into the rinsing water (due to normal mechanical abrasion) is absorbed and eliminated by the micro organisms living in the bottom of rivers or water clearing stations in a few days.



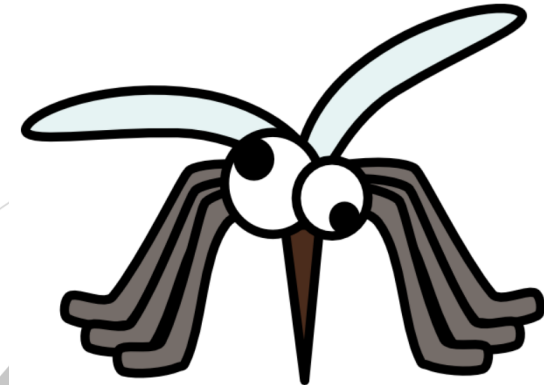
- ▶ The extent of systemic exposure following external therapeutic administration of permethrin is very low compared with doses used for preclinical toxicity studies, and **elimination is virtually complete after 1 week**. These data provide the pharmacokinetic basis for the clinical safety of topical permethrin.
- ▶ <https://link.springer.com/article/10.1007%2Fsoo228-005-0932-7>

Conclusion

It is clearly not only the chemical „permethrin“ which gives the correct protection, but a whole array of parameters which **assure both the efficiency towards the wectors**, as well **guarantee the low-risk** effect of the people wearing the garments. The delicate balance between bioactivity, bioavailability and health-effects on the wearer have to be constantly monitored. This is an operation which can only be entrusted to **strictly selected companies** and **laboratories** who have a proven track-record in this field, and who have passed all **independent** tests. There are already many **civilian copies** on the market who want to benefit from the extensive military studies, but as long as they have not undergone all the same tests, they are not to be taken as valid alternatives as the long-term health risk cannot be assessed correctly.



- ▶ In Europe, there is **one patent-holder** for the production and sales of fabrics treated with permethrin and copolymer matrix, ensuring washability up to 80 or 100 washes (**Utexbel**, Belgium).
- ▶ However, the technology is being put at the disposal of all candidates who wish to produce these fabrics, after mutual written agreement.
- ▶ Utexbel grants use (without fee) of the patented technology to the governmental bodies who wish to apply this to their uniforms.



utexbel

PASSION>PROCESS>PROGRESS

S.A. UTEXBEL Avenue C. Snoeck 30 B 9600 Renaix

Cotton / PA 6.6 Nylon 50/50
RIPSTOP



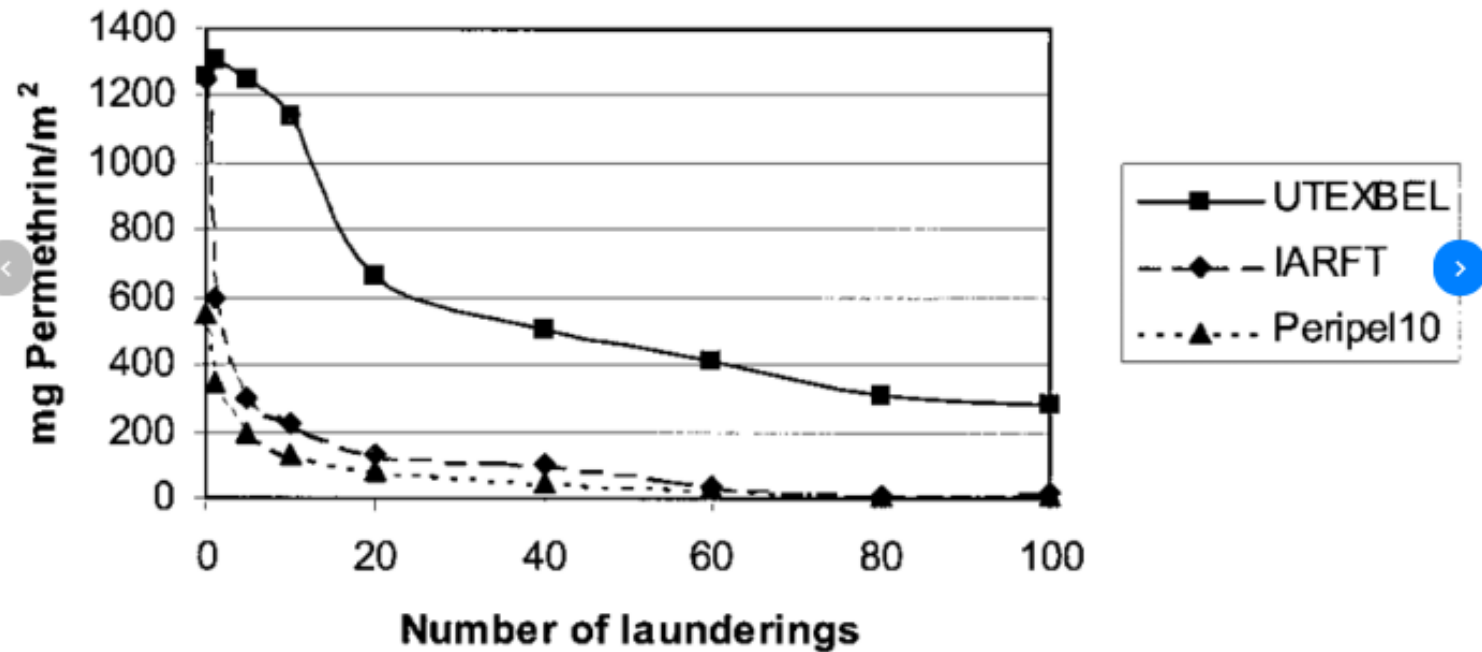
 **Interreg**
Baltic Sea Region



SWW
smart & safe
work wear

- ▶ Permethrin Impregnation of Fabric Factory-based permethrin-impregnated military battle dress uniforms (BDUs) were supplied by UTEXBEL S.A. (Ronse, Belgium). **Fabrics were polymer-coated with permethrin (cis: trans 25:75) after the dyeing process, but before tailoring.** This method yielded a theoretical permethrin concentration of 1,300 mg active ingredient (a.i.)/m², and fabrics were dried by in-process heating at 130°C.
- ▶ Uniforms impregnated by the Insect/Arthropod Repellent Fabric Treatment (IARFT) method (Coulston Products Inc., Easton, Pennsylvania) were “dipped” according to the manufacturer’s instructions.

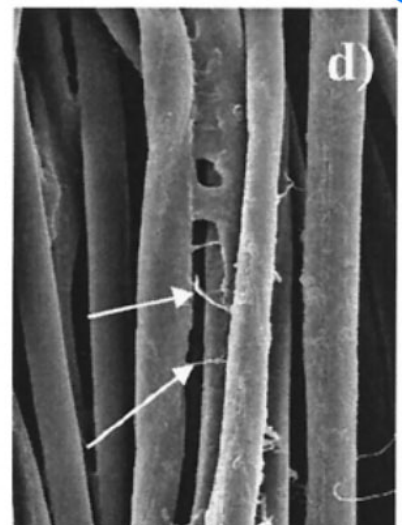
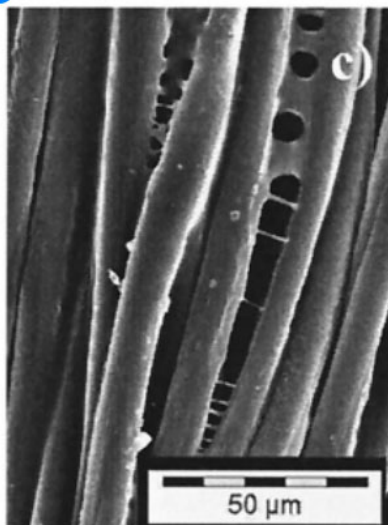
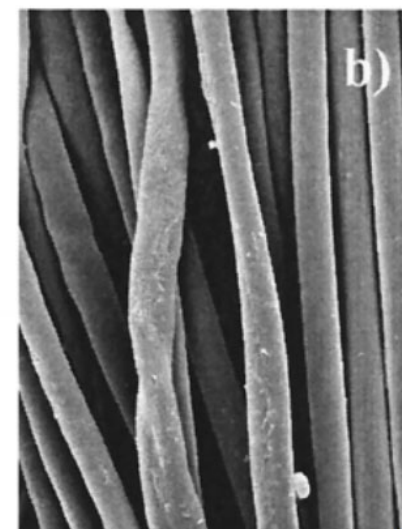
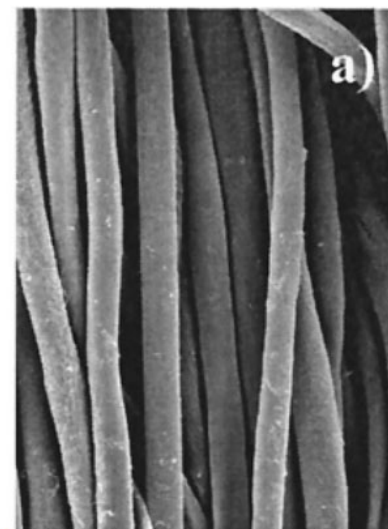
Permethrin quantification after laundering



Residual quantities of permethrin prior to and after 1, 5, 10, 20, 40, 60, 80, and 100 launderings.

Scanning electron microscopy results
(magnification rate 500x):

- a) Fabric fibers treated with Peripel 10 prior to laundering;
- b) Fabric fibers treated with IARFT prior to laundering;
- c) Fabric fibers treated with the polymer-coating method prior to laundering;
- d) Fabric fibers treated with the polymer-coating method after 10launders;



Fabrics for summer combat clothing

FABRIC	WEIGHT	COMPOSITION	CONSTRUCTION	ABRASION	TENSILE STR.	TEAR STR.
<u>CARRINGTON</u>						
COOLTEX 3	275 g/m ²	50% CO 50% PES	4/1 satin	55 000	1700/700 N	47/32 N
DELTA	210 g/m ²	65% PES 35% CO	2/1 twill	45 000	1250/620 N	42/32 N
SPARTAN	210 g/m ²	50% NY 50% CO	RIPSTOP	70 000	850/350 N	35/20 N
HUDSON	270 g/m ²	65% PES 35% CO	RIPSTOP	40 000	1450/850 N	50/40 N
TROY	245 g/m ²	60% CO 40% PES	2/1 twill	40 000	1050/550 N	32/27 N
ULTRA	215 g/m ²	50% CO 50% PES	2/1 Twill	30 000	900/700 N	30/35 N
PYTHON	235 g/m ²	70% PES 30% CO	3/1 Twill	80 000	1250/1100 N	45/40 N
<u>UTEXBEL</u>						
9706	195 g/m ²	50% CO 50% PA 6.6 Nylon T420	RIPSTOP	125 000		60/40 N
2650	250 g/m ²	50% CO 50% PES	RIPSTOP	50 000		60/60 N

Physical properties of summer combat clothing fabric

ART.	SPARTAN	HUDSON SININE	HUDSON HALL	FLAMETOUGHTER	EXCALIBUR	UTEXBEL 9706
TEST	210 g/m2	270 g/m2	270 g/m2	280 g/m2	170 g/m2	195 g/m2
	RIPSTOP	RIPSTOP	RIPSTOP	3/1 TWILL	RIPSTOP	RIPSTOP
7000 pööret						
Martindale pilling						
ISO 12945-2:2000						
vastu testitavat	(4/) 5	(4/) 5	(4/) 5	4	(4/) 5	4/5
vastu hõõrdekangast	(4/) 5	(4/) 5	(4/) 5	4	3	4/5
MARTINDALE hõõrdekindlus						
ISO 12947-1:2001	70000	40000	40000	85000	30000	200000
ISO 12947-2:2016						
Katkevuskooormus, max force						
EN ISO 13934-1:2013						
lõim	1351,90	1754,11	1655,26	968,88	723,44	1224,37
kude	538,63	946,68	993,10	709,30	558,84	576,65
pikenemine %, max force						
lõim	34,69	27,15	29,44	11,97	10,33	36,39
kude	21,25	17,80	17,53	15,69	16,40	23,31
Rebimistugevus, Elmendorf						
EVS-EN ISO 13937-1:2000						
lõim	38,00	41,27	39,70	32,67	40,80	74,32
kude	15,77	26,28	24,80	40,01	41,08	39,30
keskmine	26,88	33,78	32,25	36,34	40,94	56,81

	Fabric without repellent	Fabric with repellent
Air permeability (EN ISO 9237:2001)	50 ± 10 mm/s	43 ± 10 mm/s
Water vapour resistance (EN ISO 11092:2014)	4.1 ± 0.3 m ² Pa/ W	4.8 ± 0.2 m ² Pa/ W

- ▶ <https://web.archive.org/web/20070927094027/http://npic.orst.edu/factsheets/permethrin.pdf>
- ▶ <http://npic.orst.edu/pest/mosquito/ptc.html>
- ▶ <http://npic.orst.edu/factsheets/PermGen.pdf>
- ▶ <https://www.ghdonline.org/uploads/ADA511583.pdf> (UTEXBEL) - annex1
- ▶ <https://www.ncbi.nlm.nih.gov/pubmed/18222725> - annex2
- ▶ <https://www.ncbi.nlm.nih.gov/pubmed/16808123> annex 3
- ▶ <https://www.researchgate.net/publication/237740074> Chapter 7 - HUMAN EXPOSURE BIOMARKERS PERMETHRIN AS A MILITARILY-RELEVANT MODEL annex4