

**WHO SPECIFICATIONS AND EVALUATIONS  
FOR PUBLIC HEALTH PESTICIDES**

**ALPHA-CYPERMETHRIN**

**LONG-LASTING (COATED ONTO FILAMENTS)  
INSECTICIDAL NET**

A racemic mixture of:

(*S*)- $\alpha$ -cyano-3-phenoxybenzyl-(1*R*,3*R*)-3-(2,2-dichlorovinyl)-  
2,2-dimethylcyclopropane-carboxylate and  
(*R*)- $\alpha$ -cyano-3-phenoxybenzyl-(1*S*,3*S*)-3-(2,2-dichlorovinyl)-  
2,2-dimethylcyclopropane-carboxylate



**World Health  
Organization**

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## Disclaimer<sup>1</sup>

WHO specifications are developed with the basic objective of promoting, as far as practicable, the manufacture, distribution and use of pesticides that meet basic quality requirements.

Compliance with the specifications does not constitute an endorsement or warranty of the fitness of a particular pesticide for a particular purpose, including its suitability for the control of any given pest, or its suitability for use in a particular area. Owing to the complexity of the problems involved, the suitability of pesticides for a particular purpose and the content of the labelling instructions must be decided at the national or provincial level.

Furthermore, pesticides which are manufactured to comply with these specifications are not exempted from any safety regulation or other legal or administrative provision applicable to their manufacture, sale, transportation, storage, handling, preparation and/or use.

WHO disclaims any and all liability for any injury, death, loss, damage or other prejudice of any kind that may be arise as a result of, or in connection with, the manufacture, sale, transportation, storage, handling, preparation and/or use of pesticides which are found, or are claimed, to have been manufactured to comply with these specifications.

Additionally, WHO wishes to alert users to the fact that improper storage, handling, preparation and/or use of pesticides can result in either a lowering or complete loss of safety and/or efficacy.

WHO is not responsible, and does not accept any liability, for the testing of pesticides for compliance with the specifications, nor for any methods recommended and/or used for testing compliance. As a result, WHO does not in any way warrant or represent that any pesticide claimed to comply with a WHO specification actually does so.

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<sup>1</sup> This disclaimer applies to all specifications published by WHO.

## INTRODUCTION

WHO establishes and publishes specifications\* for technical material and related formulations of public health pesticides with the objective that these specifications may be used to provide an international point of reference against which products can be judged either for regulatory purposes or in commercial dealings.

From 2002, the development of WHO specifications follows the **New Procedure**, described in the Manual for Development and Use of FAO and WHO Specifications for Pesticides. This **New Procedure** follows a formal and transparent evaluation process. It describes the minimum data package, the procedure and evaluation applied by WHO and the experts of the “FAO/WHO Joint Meeting on Pesticide Specifications” (JMPS).

WHO Specifications now only apply to products for which the technical materials have been evaluated. Consequently, from the year 2002 onwards the publication of WHO specifications under the **New Procedure** has changed. Every specification consists now of two parts, namely the specifications and the evaluation report(s):

**Part One:** The Specification of the technical material and the related formulations of the pesticide in accordance with chapters 4 to 9 of the above-mentioned manual.

**Part Two:** The Evaluation Report(s) of the pesticide, reflecting the evaluation of the data package carried out by WHO and the JMPS. The data are provided by the manufacturer(s) according to the requirements of chapter 3 of the above-mentioned manual and supported by other information sources. The Evaluation Report includes the name(s) of the manufacturer(s) whose technical material has been evaluated. Evaluation reports on specifications developed subsequently to the original set of specifications are added in a chronological order to this report.

WHO specifications under the **New Procedure** do not necessarily apply to nominally similar products of other manufacturer(s), nor to those where the active ingredient is produced by other routes of manufacture. WHO has the possibility to extend the scope of the specifications to similar products but only when the JMPS has been satisfied that the additional products are equivalent to that which formed the basis of the reference specification.

**Specifications bear the date (month and year) of publication of the current version. Evaluations bear the date (year) of the meeting at which the recommendations were made by the JMPS.**

\* Footnote: The publications are available on the Internet under (<http://www.who.int/whopes/quality/en/>).

**PART ONE**  
**SPECIFICATIONS**

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# WHO SPECIFICATIONS FOR PUBLIC HEALTH PESTICIDES

## ALPHA-CYPERMETHRIN

### INFORMATION

*Common name*

alpha-cypermethrin (E-ISO, BSI), alpha-cyperméthrine (F-ISO)

*Synonyms*

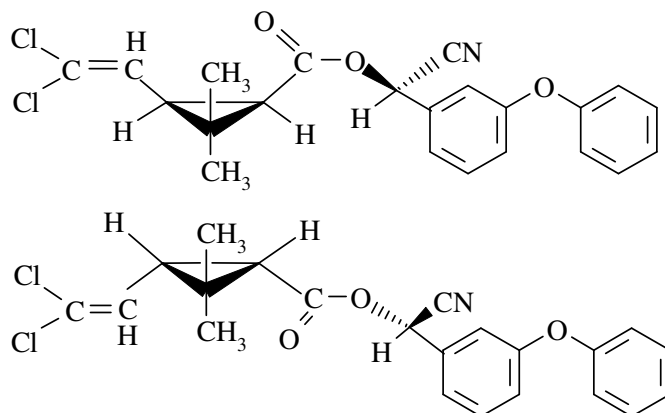
alphamethrin (rejected common name), alfoxylate

*Chemical names*

*IUPAC* a racemic mixture of: (*S*)- $\alpha$ -cyano-3-phenoxybenzyl-(1*R*,3*R*)-3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropanecarboxylate and (*R*)- $\alpha$ -cyano-3-phenoxybenzyl-(1*S*,3*S*)-3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropanecarboxylate

*CA:* [1 $\alpha$ (*S*\*),3 $\alpha$ ]-( $\pm$ )-cyano(3-phenoxyphenyl)methyl 3-(2,2-dichloroethenyl)-2,2-dimethylcyclopropanecarboxylate

*Structural formula*



*Empirical formula*

C<sub>22</sub>H<sub>19</sub>Cl<sub>2</sub>NO<sub>3</sub>

*Relative molecular mass*

416.3

*CAS Registry number*

67375-30-8

*CIPAC number*

454

*Identity tests*

GC retention time, IR spectrum.

# WHO SPECIFICATIONS FOR PUBLIC HEALTH PESTICIDES

## ALPHA-CYPERMETHRIN LONG-LASTING (COATED ONTO FILAMENTS) INSECTICIDAL NET

WHO specification 454/LN/1 (August 2015\*)

*This specification, which is PART ONE of this publication, is based on an evaluation of data submitted by the manufacturers whose names are listed in the evaluation reports (454/2009.1, 454/2015.1, 454/2015.2). It should be applicable to relevant products of these manufacturers but it is not an endorsement of those products, nor a guarantee that they comply with the specification. The specification may not be appropriate for the products of other manufacturers, irrespective of the source of TC. The evaluation reports (454/2009.1, 454/2015.1, 454/2015.2), given in PART TWO, forms an integral part of this publication.*

### 1 Description

The product shall be in the form of netting (Note 1), consisting of 75 or 100 denier multi-filament (minimum 32 filaments) polyester fibres, treated with a formulation containing technical alpha-cypermethrin complying with the requirements of WHO specification 454/SC (February 2015), and a polymeric binder together with any necessary formulants. The product shall appear clean and shall be free from visible extraneous matter (Note 2), visible damage (such as splitting or tearing) and visible manufacturing defects (such as poorly made seams or a weave that is either not uniform or too loose to remain uniform in use). It shall be suitable for use as an insecticidal net with long-lasting activity (Notes 3 & 4).

### 2 Active ingredient

#### 2.1 Identity tests (454/LN/M/2, CIPAC Handbook M, p.40, 2009)

The active ingredient shall comply with an identity test and, where the identity remains in doubt, shall comply with at least one additional test.

#### 2.2 Alpha-cypermethrin content (454/LN/M/3.1, CIPAC Handbook M, p.40, 2009) (Notes 5 & 6)

The alpha-cypermethrin content shall be declared (6.7 g/kg for 75 denier yarn and 5.0 g/kg for 100 denier yarn) and, when determined, the average measured content shall not differ from that declared by more than  $\pm 25\%$ .

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\* This specification is applicable to long-lasting (coated onto filaments) insecticidal nettings and nets produced by BASF and Mainpol GmbH and commercialized under the trade names of Interceptor® and SafeNet® respectively. The subject of the extension of specifications for LN has been discussed by the JMPS in 2009. The Meeting agreed that - in contrast to other formulations - an extension of a specification to nominally similar LN of other manufacturers was not possible with the data currently available and that the manufacturer and the product should be named in a footnote or in the specification.

Specifications may be revised and/or additional evaluations may be undertaken.  
Ensure the use of current versions by checking at: <http://www.who.int/whopes/quality/en/>.

### 2.3 **Alpha-cypermethrin wash resistance index** (MT 195) (Note 7)

The wash resistance index of alpha-cypermethrin from the netting, when determined, shall be within the range 90% to 101%.

## 3 **Physical properties**

### 3.1 **Netting mesh size** (Note 5)

When counted by the method given in Note 8, the netting shall have a minimum of 24 complete holes/cm<sup>2</sup>.

### 3.2 **Dimensional stability of netting to washing** (Notes 5 & 9)

Not more than 5% shrinkage/expansion in both dimensions.

### 3.3 **Bursting strength** (Notes 5 & 10)

The minimum bursting strength of the fabric shall be declared (not less than 250 kPa for 75 denier yarn, not less than 405 kPa for 100 denier yarn) and, when determined, the average shall be not less than that declared.

If seams are present, their average bursting strength shall be not less than the measured average for the fabric.

## 4 **Storage stability**

### 4.1 **Stability at elevated temperature** (MT 46.3.4) (Note 11)

After storage at  $54 \pm 2^\circ\text{C}$  for 2 weeks, the determined average active ingredient content shall not be lower than 95%, relative to the determined average content found before storage (Note 12) and the product shall continue to comply with the clauses for:

- wash resistance index (2.3);
- dimensional stability (3.2);
- bursting strength (3.3).

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Note 1 The specification applies to manufactured nets and bulk netting.

Note 2 Occasional short lengths of loose thread present in the netting are not considered to be extraneous matter.

Note 3 Long-lasting insecticidal netting is expected to retain its insecticidal activity during its life span and through a number of washes.

Note 4 Flammability of the product is not part of the specification but it should be measured by the manufacturer, according to 16CFR Part 1610, and the result presented on the package. The linear density (denier) of the fibres cannot be measured in the netting or the manufactured bed net but it should be identified on the packaging.



Note 5 Samples should be taken according to Figure 1 or on a convenient diagonal across the width of bulk material. Samples must be sufficiently large to conduct all tests required and representative of the net or netting. Except where seams are to be tested, do not test material within 10 cm of seams or selvages.

Use sharp scissors, or equivalent, to minimize damage to the fibres and fabric and thus avoid any consequential bias in the results of certain tests. Roll up the strips or squares and place them in labelled, new, clean aluminium foil prior to analysis. Samples should be kept cool, avoiding heat sources (including sun heat) or freezing, and analyzed/tested with minimum delay. Representative portions (sub-samples) for testing should be taken as described in each test method.

Note 6 The target content of alpha-cypermethrin of 6.7 and 5.0 g/kg for the 75 and 100 denier yarn netting or net, respectively, corresponds to 200 mg/m<sup>2</sup> in both cases with a tolerance of  $\pm 50$  mg/m<sup>2</sup>. This value can be calculated from values for active ingredient content in g/kg and mass of net/m<sup>2</sup>. Mass of net/m<sup>2</sup> should be determined according to ISO 3801 (1977). In cases of dispute, g/kg values shall be used.

Note 7 The method MT 195 for determination of wash resistance index of LN was adopted as full CIPAC MT method in 2013. Prior to its publication in the next Handbook, copies of the method can be obtained through the CIPAC website, <http://www.cipac.org/prepubme.htm>

The content of alpha-cypermethrin in the net pieces before and after washing should be determined by the method 454/LN/M/3.1, CIPAC Handbook M, p.40, 2009. Wash resistance index values higher than 100% up to 101% are acceptable due to the uncertainty of measurement of the CIPAC method MT 195.

Note 8 In the absence of a simple or standard method to determine the size of holes, which may have complex shapes, in highly flexible fabrics, mesh size is determined by counting the number of holes in a square of the fabric. Counting may be done directly on the fabric or indirectly by taking a picture/photocopy of the fabric. Indirect methods may ease counting and provide a permanent record. Before counting, the fabric should be conditioned according to ISO 139 (1973) (4 h, 20°C, 65% relative humidity).

Use a template to define the square of netting, taking care not to stretch or distort the fabric. The template should be a 1-2 mm thick rigid sheet, in/on which an accurately calibrated ( $\pm 1\%$  in each dimension) square (e.g. 1 x 1 in or 5 x 5 cm) has been cut/marked. If a template is not available and a ruler must be used, great care is required to ensure that the area counted is square. Where practicable, one edge of the square to be counted should be aligned with a row of complete holes in the fabric. Incomplete holes  $\geq \frac{1}{2}$  are counted as complete holes, whereas those  $< \frac{1}{2}$  are not counted. Count 5 replicate squares selected according to Note 5, calculate the average and note the lowest value.

Note 9 Method of preparation, marking and measuring: ISO 3759 (2007). Method of washing: ISO 6330 (2001). Method of calculation: ISO 5077 (1984). Size of test portions: 500 mm x 500 mm; mark off 350 mm x 350 mm within each test portion. Test a total of 4 replicate portions, 2 washed in each of 2 separate loads. Type of washing machine: ISO type A (front loading). Washing programme: ISO type 8A (gentle cycle 30°C). Fill the washer with dummy load (with fabric as per ISO standard) up to the standard of 2 to 4 kg. Drying: flat drying.

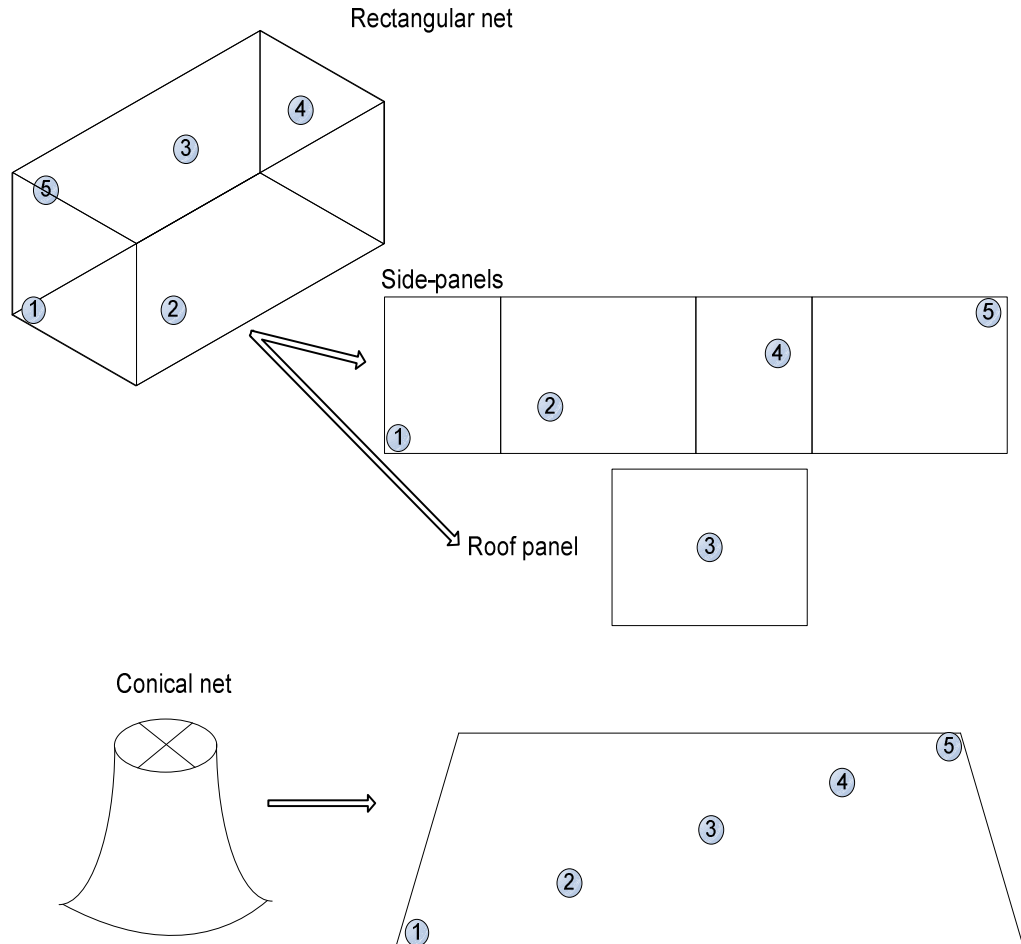
Note 10 Test method: ISO 13938 part 2 (1999), with conditioning of the fabric as specified in the ISO standard. The declared minimum bursting strength, and testing for compliance with it, should be based on tests of 7.3 cm<sup>2</sup> areas of fabric. Five replicate tests should be conducted on samples taken at approximately equal distances on a diagonal across the netting, taking no sample within 10 cm of a border or seam. In made up rectangular nets, the "diagonal" may correspond to one produced by conceptually arranging the panels end to end). The average of the 5 measurements is calculated.

The method to test seam bursting strength is identical to that used to test the fabric, except that 5 replicate tests should be made, with the seam centred on the test head. Up to 5 seams may be tested but, if there are  $< 5$  seams, replicate measurements should be made on 1 or more seams, to provide a total of 5 measurements.

Note 11 The extension of the scope (CIPAC/4956) of CIPAC method MT 46.3 for the accelerated storage procedure of the LN formulations regarding determination of active ingredient content and wash resistance index was adopted as a provisional CIPAC MT method in 2014. Prior to its publication in the next Handbook, copies of the method can be obtained through the CIPAC website, <http://www.cipac.org/prepubme.htm>

Note 12 Samples of the product taken before and after the storage stability test should be analyzed concurrently after the test in order to reduce the analytical error.

Figure 1 Recommended positions from which 5 pieces of netting should be taken from a made up bed net and combined to form a representative sample.



**PART TWO**  
**EVALUATION REPORTS**

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**ALPHA-CYPERMETHRIN**

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# WHO SPECIFICATIONS FOR PUBLIC HEALTH PESTICIDES

## ALPHA-CYPERMETHRIN

### FAO/WHO EVALUATION REPORT 454/2015.2

#### **Recommendations**

The Meeting recommended the following:

The existing WHO specification 454/LN/1 for alpha-cypermethrin (coated onto filaments) LN should be extended to encompass the corresponding product of Mainpol GmbH.

#### **Appraisal**

Supporting data and information for alpha-cypermethrin long-lasting (coated onto filaments) insecticidal net (LN), provided by Mainpol GmbH (Germany) were considered by the Meeting for extension of the existing WHO specification 454/LN/1 (October 2009). The data and test reports provided by the manufacturer to support this extension were generated by the manufacturer as well as by an independent laboratory.

The LN under consideration (SafeNet) is a warp knitted fabric consisting of 75 or 100 denier multi-filament polyester fibers (minimum 32 filaments) treated with an aqueous suspension concentrate (SC) containing alpha-cypermethrin. The impregnation technology is based on coating the insecticide onto the polyester netting fabric (after the knitting process) using a polymeric binding system that make it suitable for use as an insecticidal net with long-lasting activity.

The manufacturer provided written confirmation that the alpha-cypermethrin SC formulation used to coat the net and the alpha-cypermethrin technical material (TC) used in the SC formulation are from a source compliant with the existing WHO specifications for alpha-cypermethrin SC and TC, respectively (Meghmani Organics Limited).

SafeNet was tested and evaluated by WHOPES who concluded that the wash-resistance and bioefficacy are comparable to the reference product (Interceptor) (WHO 2015).

#### Description

The Meeting concluded that the description of SafeNet made of 75 or 100 denier warp-knitted multi-filament polyester fibres and treated with an aqueous suspension concentrate (SC) containing alpha-cypermethrin complies with the existing WHO specifications 454/LN/1.

#### Active ingredient identity and content

The target alpha-cypermethrin content of SafeNet is 6.7 and 5.0 g per kg of netting material for 75 and 100 denier yarns respectively, corresponding to 200 mg/m<sup>2</sup> for both deniers. Data provided by the manufacturer for alpha-cypermethrin content in several batches showed that the product complies with the existing WHO specification 454/LN/1.

The CIPAC method 454/LN/M/3.1 published in Handbook M was used in the studies provided by the manufacturer and is fully applicable for SafeNet. The content of alpha-cypermethrin is determined by capillary gas chromatography using flame ionisation detection (GC-FID) and dioctyl phthalate as internal standard, after extraction by refluxing with tetrahydrofuran for 5 minutes. Citric acid is added into the GC vial to avoid the epimerization of alpha-cypermethrin in the inlet of the GC.

Special attention needs to be paid to control random variations in the distribution of the insecticide over the surface of the net and between nets. The spatial variation data provided by the manufacturer (alpha-cypermethrin content on 5 individual net pieces taken according to the Figure 1 of the specification) showed a good homogeneity of the active ingredient content within the net (within-net RSD = 4.1% before storage and 7.7% after accelerated storage at 54°C for 2 weeks).

The WHOPES Phase I testing and evaluation of SafeNet showed that alpha-cypermethrin content in the unwashed nets fully comply with the target dose of 6.7 g/kg  $\pm$  25% for 100 denier yarn, and a good homogeneity of the active ingredient distribution within and between the nets. The within-net variation, expressed as the relative standard deviation (RSD) of the content found on 5 pieces taken from each side and roof of the same net, ranged from 5.0% to 9.0%. The between-net variation, expressed as the relative standard deviation (RSD) of the content found on 4 different nets, was 2.9% (CRA-W 2015, WHO 2015).

#### Active ingredient wash resistance index

An adequate amount of active ingredient must be present at the surface of the LN, for efficacy reasons, whereas the majority must reside within the coating of the LN, to avoid excessive losses during washing and to provide a reservoir from which the surface is replenished with active ingredient. The depth and properties of coating therefore strongly influence the retention of alpha-cypermethrin when the LN is subjected to repeated washing. Depletion of total active ingredient content by washing (wash resistance index) is accomplished by analyzing separate washed and unwashed pieces of the same fabric.

The method MT 195 for determination of wash resistance index of LN was adopted as full CIPAC method in 2013. This method is a further standardization of the WHO washing method published in the "WHO Guidelines for laboratory and field testing of long-lasting insecticidal mosquito nets", document WHO/CDS/WHOPES/GCDPP/2005.11 (WHO 2005). Briefly, the wash resistance index is determined by analyzing net samples in triplicate representing wash points 0 and 4 for total active ingredient content and calculating the average wash resistance index per wash using the equation for a free migration stage behaviour. A wash resistance index per wash of 95% indicates that at least 95% of the insecticide present in samples washed 1 to 3 times is still present after an additional wash step. The wash resistance index applies to the average obtained from triplicate tests performed on net pieces removed from the same net or batch of netting (CIPAC 2013).

Data provided by the manufacturer for alpha-cypermethrin wash resistance index in several batches according to the CIPAC method MT 195 showed that the product complies with the existing WHO specification 454/LN/1 (wash resistance index ranging from 92.5% to 97.0%).

The WHOPES Phase I testing results on alpha-cypermethrin content and associated biological efficacy of SafeNet washed up to 25 times (according to the WHO washing method) showed an exponential decay of the alpha-cypermethrin content in function of the number of washes (free-migration stage behaviour). The overall alpha-cypermethrin retention after 20 washes was 48.5%, corresponding to an average wash resistance index of 97.2%, as estimated by the exponential regression curve (CRA-W 2015, WHO 2015).

#### Relevant impurities

There are no relevant impurities identified in the existing WHO specifications for alpha-cypermethrin TC, SC and LN.

#### Physical properties

The manufacturer provided study reports on SafeNet of 75 denier and 100 denier showing that the product complies with the clauses of the existing WHO specification 454/LN/1 for netting mesh size, dimensional stability of netting to washing and bursting strength (net fabric and seams).

#### Storage stability

The manufacturer provided data after storage at 54 °C for 2 weeks showing that the loss of alpha-cypermethrin is less than 5% relative to the average content found before storage and that the net still complies with the limits of the existing specification for wash resistance index, dimensional stability to washing and bursting strength.

## ANNEX 1: REFERENCES

Study number	Author(s)	Year	Study title. Study identification number. Report identification number. GLP [if GLP]. Company conducting the study
	CIPAC	2013	MT 195. Wash resistance index of LN, available at <a href="http://www.cipac.org/prepubme.htm">http://www.cipac.org/prepubme.htm</a>
RE/15/U10/23866	CRA-W	2015	Determination of alpha-cypermethrin in SafeNet and Interceptor from the WHOPES Phase I testing and evaluation of SafeNet. Test report RE/15/U10/23866 of the Walloon Agricultural Research Centre, Gembloux, Belgium for WHO, March 16, 2015.
	FAO/WHO	2010	Manual on development and use of FAO and WHO specifications for pesticides. Second revision of the 1 <sup>st</sup> edition. FAO, Rome and WHO, Geneva, November 2010 (internet publications).
	Pérez Rafael	2013	Application package for Mapomol® SafeNet. Data package submitted to JMPS. Mainpol GmbH, 4 October 2013.
719194286-MEC11/01-HWC	TÜV SÜD PSB	2011	Testing of mosquito nets submitted by Mainpol GmbH on 17 Jan 2011. Report 719194286-MEC11/01-HWC of TÜV SÜD PSB for Mainpol GmbH, January 2011.
7191070597-CHM13-CSY	TÜV SÜD PSB	2013	Chemical analysis of Mosquito Net Sample. Report 7191070597-CHM13-CSY of TÜV SÜD PSB for Mainpol GmbH, October 2013.
7191080882-CHM14-CSY	TÜV SÜD PSB	2014	Chemical analysis of Mosquito Net Sample. Report 7191080882-CHM14-CSY of TÜV SÜD PSB for Mainpol GmbH, February 2014.
7191082677-CHM14-CSY	TÜV SÜD PSB	2014	Chemical analysis of Mosquito Net Sample. Report 7191082677-CHM14-CSY of TÜV SÜD PSB for Mainpol GmbH, March 2014.
7191082678-CHM14-CSY	TÜV SÜD PSB	2014	Chemical analysis of Mosquito Net Sample. Report 7191082678-CHM14-CSY of TÜV SÜD PSB for Mainpol GmbH, March 2014.
7191095809-EEC14/01-CSL	TÜV SÜD PSB	2014	Testing of mosquito nets submitted by MAINPOL GmbH on 28 Aug 2014. Report 7191095809-EEC14/01-CSL of TÜV SÜD PSB for Mainpol GmbH, September 2014.
7191098837-EEC14-CSL	TÜV SÜD PSB	2014	Testing of mosquito nets submitted by MAINPOL GmbH on 28 Aug 2014. Report 7191098837-EEC14-CSL of TÜV SÜD PSB for Mainpol GmbH, September 2014.
7191099167-EEC14/01-CSL	TÜV SÜD PSB	2014	Testing of mosquito nets submitted by MAINPOL GmbH on 15 Oct 2014. Report 7191099167-EEC14/01-CSL of TÜV SÜD PSB for Mainpol GmbH, October 2014.
	WHO	2005	Guidelines for laboratory and field testing of long-lasting insecticidal mosquito nets. Document WHO/CDS/WHOPES/GCDPP/2005.11. WHO, Geneva, 2005.
	WHO	2015	Report of the Eighteenth WHOPES Working Group Meeting, WHO/HQ, Geneva, 29 June - 1 July 2015.

## WHO SPECIFICATIONS FOR PUBLIC HEALTH PESTICIDES

### ALPHA-CYPERMETHRIN

#### FAO/WHO EVALUATION REPORT 454/2015.1

#### **Recommendations**

The Meeting recommended the following:

- (i) The wash resistance index tolerance of the existing WHO specification 454/LN/1 for alpha-cypermethrin long-lasting (coated onto filaments) insecticidal net (LN) using the new CIPAC washing method MT 195 should be revised to the range of 90% to 101%.
- (ii) The revised specification should get the status of full WHO specification.

#### **Appraisal**

The method MT 195 for determination of wash resistance index of LN was adopted as full CIPAC method in 2013. This method is a further standardization of the WHO washing method published in the “WHO Guidelines for laboratory and field testing of long-lasting insecticidal mosquito nets”, document WHO/CDS/WHOPES/GCDPP/ 2005.11, WHO, Geneva, 2005 (WHO 2005). Briefly, the wash resistance index is determined by analyzing net samples in triplicate representing wash points 0 and 4 for total active ingredient content and calculating the average wash resistance index per wash using the equation for free migration stage behaviour. A wash resistance index per wash of 95% indicates that at least 95% of the insecticide present in samples washed 1 to 3 times is still present after an additional wash step. The wash resistance index applies to the average obtained from triplicate tests performed on net pieces removed from the same net or batch of netting (CIPAC 2012 and 2013).

The Meeting requested BASF producing alpha-cypermethrin long-lasting (coated onto filaments) insecticidal net (LN) (Interceptor®) to generate wash resistance index data using the new CIPAC washing method MT 195 and to propose a revised wash resistance index clause based on these data.

The manufacturer provided the Meeting with wash resistance index data from two different laboratories according to the CIPAC method MT 195. In the two study reports, the wash resistance index was measured on 2 Interceptor (75 and 100 denier) using 2 different sources of polyoxyethylene glycol (25) monostearate as a component of the washing agent. The wash resistance index ranged from 91.7% to 99.3%.

These results confirmed those obtained in the CIPAC small scale collaborative trial performed in 2012 on Interceptor, 75 denier (wash resistance index ranging from 90.9% to 99.2%).

Based on these results, the manufacturer proposed to revise the wash resistance index tolerance from 90%-98% to 90-101%, and it was agreed by the Meeting.



The Meeting agreed also:

- to refer only to the standard pneumatic method (EN ISO 13938-2) for bursting strength, as recommended in the report of the WHO consultation of August 2014 on fabric strength of LNs.
- to refer to the method MT 46.3.4 adopted as full CIPAC MT method in 2015 for accelerated storage procedure and to update some footnotes of the existing specification to be in line with the draft specification guideline for LN of the November 2010 - second revision of the first edition of the FAO/WHO Manual.

## ANNEX 1: REFERENCES

Study number	Author(s)	Year	Study title. Study identification number. Report identification number. GLP [if GLP]. Company conducting the study
	CIPAC	2012	MT 19X. Wash resistance index of LN, CIPAC method 4827/m.
	CIPAC	2012	MT 19X. Wash resistance index of LN, small scale collaborative trial, CIPAC report 4828/R.
	CIPAC	2013	MT 195. Wash resistance index of LN, available at <a href="http://www.cipac.org/cipacpub.htm">http://www.cipac.org/cipacpub.htm</a>
	CIPAC	2013	Wash resistance index of LN - Validation of the new CIPAC Washing Method, CIPAC report 4909/R.
RE/13/U10/ 23297	CRA-W	2013	Alpha-cypermethrin wash resistance index of Interceptor, 75 and 100 denier. Report RE/13/U10/23297 of the Walloon Agricultural Research Centre, Gembloux, Belgium for BASF, October 04, 2013.
	FAO/WHO	2010	Manual on development and use of FAO and WHO specifications for pesticides. Second revision of the 1 <sup>st</sup> edition. FAO, Rome and WHO, Geneva, November 2010 (internet publications).
	Weinmüller Egon	2015	Wash resistance index data on Interceptor LN according to the new CIPAC method MT 195. BASF, June 25, 2015.
	WHO	2005	Guidelines for laboratory and field testing of long-lasting insecticidal mosquito nets. Document WHO/CDS/WHOPES/GCDPP/2005.11. WHO, Geneva, 2005.
	WHO	2015	Determination of fabric strength of long-lasting insecticidal nets. Report of a WHO consultation, Geneva, 20-22 August 2014. WHO, Geneva, document WHO/HTM/NTD/WHOPES/2015.1.

## WHO SPECIFICATIONS FOR PUBLIC HEALTH PESTICIDES

### ALPHA-CYPERMETHRIN

#### FAO/WHO EVALUATION REPORT 454/2009.1

#### **Recommendations**

The Meeting recommended that a time-limited interim specification (until October 2012) for alpha-cypermethrin long-lasting (coated onto filaments) insecticidal net proposed by BASF, as amended, should be adopted by WHO.

#### **Appraisal**

Supporting data and draft specifications for alpha-cypermethrin long-lasting (coated onto filaments) insecticidal net (LN), were provided by BASF in 2005 and additional studies were submitted in following years. The documents were considered by the Meeting for development of a new WHO specification. Appropriate clauses, limits and methods of testing for certain parameters of this new type of formulation were also developed by the company over this period.

The alpha-cypermethrin (coated onto filaments) LN produced by this manufacturer was tested/evaluated under the auspices of WHOPEP and an interim recommendation for their use in malaria prevention and control was issued in 2007 (WHO 2007).

A provisional specification guideline for LN formulations was accepted by the JMPS in 2004 and published by WHO. The guideline for LN was subsequently amended, taking into account the recommendations of a WHO consultation on mosquito nets (WHO 2005) and published in the revised manual (FAO/WHO 2006). However, the apparent diversity of LN technologies currently requires specification clauses and limits to be tailored to individual products.

The LN under consideration is a warp-knitted fabric with the active ingredient, alpha-cypermethrin, coated onto the polyester netting after the knitting process. The yarn used to produce the netting is a polyester polyfilament type which is subsequently coated with a formulated alpha-cypermethrin (SC) from a source compliant with the existing WHO specification for this active ingredient (BASF).

#### Description clause

The Meeting agreed that the specification should apply to white or coloured warp-knitted fabrics made from 75 or 100 denier multi-filament (minimum 32 filaments) polyester fibres and that it should apply equally to made up, ready-to-use nets (rectangular and circular) or to netting in bulk.

#### Active ingredient content clause

The target doses of alpha-cypermethrin (6.7 g/kg for the 75 denier yarn, and 5.0 g/kg for 100 denier yarn) is related to the technology, in order to achieve a satisfactory biological activity over the expected lifetime of the net. The Meeting agreed that the declared and tolerance values should be based on g/kg, with the corresponding mg/m<sup>2</sup> value (200 mg/m<sup>2</sup> for both yarns) being defined in a Note to the specification.

The Meeting observed that random variations in the distribution of alpha-cypermethrin may influence the variation in measured values for g/kg. The manufacturer provided between- and within-batch data, based on analysis of single pieces of 25 x 25 cm and variations in alpha-cypermethrin content following the sampling procedure as detailed in the LN guideline in the Manual, and demonstrated acceptable to good precision with two batches of net distributed and analyzed in three different laboratories (RSD < 3% with one batch, approx. 7 % with another batch).

The analytical method for determination of the alpha-cypermethrin content in LN coated type was validated as an extension of the existing CIPAC method for alpha-cypermethrin in other formulations and adopted as provisional method by CIPAC in 2007 and is published as a full method in Handbook M (August 2009).

#### Relevant impurities

There are no relevant impurities identified in the existing WHO specification for alpha-cypermethrin TC and SC proposed by BASF. The clause has therefore been omitted.

#### Alpha-cypermethrin retention index clause

An adequate amount of active ingredient must be present on the surface of the LN, for efficacy, but the majority must reside within the coating of the fibres of the LN, to avoid excessive losses during washing and to provide a reservoir from which the surface is replenished with active ingredient. The nature of the coating and binding material – a polymer which provides adequate protection for the reservoir of the insecticide – strongly influences the migration of alpha-cypermethrin to the surface when the LN is subjected to repeated washing. The Meeting agreed that also for coated types of LN, the retention index is the appropriate expression of the depletion and replenishment of the active ingredient on the surface of the multifilament fibre.

The manufacturer provided experimental data showing that approximately constant proportions of the remaining alpha-cypermethrin are removed from the surface of the filament by successive washings with aqueous detergent. The manufacturer proposed a range for the retention index of 0.90 as the minimum and a maximum of 0.98, which was agreed by the Meeting. When agreeing on limits in a specification, the sampling and analytical methods need to be properly validated so these limits can be checked and enforced by quality control laboratories if necessary. The upper limit of 0.98 was chosen for practicability reasons: the default precision requirement for content determination is  $\leq 5\%$ .

Sampling of alpha-cypermethrin (coated onto filaments) LN was done by cutting a total of 6 pieces for analysis. Six pieces of net (25 x 25 cm) were cut and washed for a specified number of washes using the WHO washing method (WHO 2005). After drying, the samples were again analyzed for alpha-cypermethrin content. The recommended positions from which the pieces of netting should be taken from a made up bed net are similar to those given in the manual (FAO/WHO 2006), as shown in figure 1, appended to the specification. The manufacturer's results showed certain small but measurable decrease of alpha-cypermethrin content with each washing step, with more than 90% of total alpha-cypermethrin remaining after each wash step. Using bioassays, the regeneration time required for diffusion to restore the surface concentration to full biological activity after washing was shown to be one day.

### Physical property clauses

The clauses for dimensional stability to washing and bursting strength specify ISO methods. The test method for netting mesh size does not require standardization.

The Meeting accepted the manufacturer's explanation that the test for bursting strength obviated the need for a separate clause for tearing strength.

The  $\pm 5\%$  tolerance on dimensional stability to washing was in agreement with the standard 5% given in the LN guideline (FAO/WHO 2006) and was supported by test results.

### Storage stability clause

The incorporated alpha-cypermethrin is stable over a very wide temperature range and has low volatility, providing additional protection to the active ingredient. At 54°C for 2 weeks, the loss of alpha-cypermethrin was low (approximately 2 %) and the physical properties of the fabric were maintained. The physical tests as well as the determination of the release index met the general requirements of the Manual (FAO/WHO 2006).

## ANNEX 1. REFERENCES

BASF document or other reference No.	Full reference
2005/1025927	M. Siebecker, 2005. Quantitative determination of alpha-cypermethrin: total contents and adherent contents on the surface of fibers of long-lasting insecticidal nets (LNs). BASF document 2005/1025927.
2005/1031627	J. Fries, 2005. Long lasting insecticidal nets (LNs): determination of the release or retention index of alpha-cypermethrin, final report. BASF document 2005/1031627 [a revision of BASF document 2005/1026842].
2006/1006722	Reply: Proposed WHO specification for alpha-cypermethrin LN. E-mail sent by T. Maurer to A. Hill and M. Zaim (WHO) on 19/01/06.
CIPAC H	Alpha-cypermethrin. CIPAC Handbook H, pp.14-21, Collaborative International Pesticides Analytical Council, Harpenden, U.K., 1998.
FAO/WHO 2002	Manual on development and use of FAO and WHO specifications for pesticides, 1 <sup>st</sup> edition. FAO Plant production and protection paper 173. FAO, Rome, 2002.
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LIN/06/05	J. Bonnet, S. Duchon & V. Corbel, 2005. Wash resistance and efficacy of long lasting insecticide nets from BASF against susceptible mosquitoes of <i>Anopheles gambiae</i> , final report. BASF document DOC/LIN/06/05.
LIN/IRD/O1/05	J. Bonnet, S. Duchon & V. Corbel, 2005. WHOPES phase I study on LLINs from BASF (TSA V2 181 345), final report. BASF document DOC/LIN/IRD/01/05.
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WHO 2007	Report of the Tenth WHOPES Working Group Meeting, WHO/HQ, Geneva, 11-14 December 2006. Geneva, World Health Organization, document WHO/CDS/NTD/WHOPES/2007.1
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