Technical consultation on specifications and quality control of netting materials and mosquito nets

Updated WHO specifications for netting materials and mosquito nets

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World Health Organization

LIST OF CONTENTS

Executive summary

Product specifications for mosquito netting material* were developed by WHO in the year 2000. Five years on, this meeting was called to review the experiences of industry, major procurement agencies, quality testing laboratories and scientific experts with the 2000 specifications, and to adapt the specifications to the current market context including the development of new netting technologies.

The meeting agreed to replace the 2000 material-specific specifications for polyester, polyethylene and cotton netting, and instead to develop generic specifications applicable to all netting materials irrespective of the fibres from which they are made. The core characteristics of good quality nets are: prevention of insect/vector entry; dimensional stability after washing; strength of netting materials and seams; retention of strength over a period of time (durability and storage stability) and safety for users.

The meeting agreed on the need for guidelines for procurement of mosquito nets by national malaria control programmes and other net buyers, and developed an outline of such a document for finalization by the WHO Global Malaria Programme.

The attached report summarizes the issues discussed during the meeting, provides the updated specification for mosquito nets, and identifies important research needs related to the characteristics and quality of netting material.

* In this report, the terms "netting" and "netting material" refer to the fabric, and the term "net" refers to the product made from netting/netting material, to be utilized as a vector barrier by the end-user.

Background

Specifications for, and quality control of, netting materials (fabric) and mosquito nets are important to define acceptable physical properties (e.g., strength, barrier properties, uptake of insecticide solution) of mosquito netting and nets for institutional buyers and end users. These specifications help to ensure that the net does what it is intended to do for the user.

In June 2000, WHO proposed minimum specifications for the physical characteristics of polyester netting material, the most commonly used material for mosquito nets. These specifications were developed primarily for institutional buyers and national malaria control programmes, to provide guidance for procurement as well as to facilitate quality control of mosquito nets.

Consequent to experience in this area acquired during the following five years, there was a need to update the specifications that have been proposed earlier. Some of the test methods were not clearly defined, or were difficult to use reliably or had to be modified. Moreover, certain limits initially proposed proved to be either too stringent or insufficiently stringent. Further, a new material, high-density polyethylene (HDPE), is currently widely disseminated and netting materials based on other new technologies are either becoming available or are in development.

Large-scale procurement of mosquito nets is now routinely being undertaken by institutional buyers, NGOs and national control programmes. Simple and practical guidelines are therefore needed to help inexperienced buyers, especially in national malaria control programmes, to address the issue of quality during procurement and subsequently to maintain adequate quality control.

1. INTRODUCTION

The WHO Global Malaria Programme (previously the WHO Roll Back Malaria Department) in collaboration with the Vector Biology and Control Unit of the WHO Regional Office for Africa convened a four-day Technical Consultation on Specifications and Quality Control of Netting Materials for Mosquito Nets at WHO Headquarters in Geneva, Switzerland, 29 November to 2 December 2005.

The meeting was opened by Dr Arata Kochi, Director, Global Malaria Programme. Dr Kochi stressed the importance of science and evidence-based medicine. He welcomed the opportunity to interact and work closely with industry, where the interests of WHO and industry meet based on science. Finally, he encouraged participants to reach clear consensus on the issues being discussed.

The meeting brought together: (a) manufacturers of insecticides and mosquito nets (including long-lasting insecticidal nets – LLINs*); (b) invited specialists from textile quality testing laboratories and major net procurement agencies; (c) scientists with expertise in chemistry and malaria vector control; and (d) experts from UNHCR, UNICEF and WHO (see Annex).

The first two days of the meeting were convened as plenary sessions, with industry representation. During the last two days, in a closed meeting with specialists and scientists, the updated specifications were finalized. Where insufficient information was available to make clear recommendations on the objectives, the meeting identified needs for further research.

The objectives of the meeting** were to:

- update specifications on polyester netting materials and nets;
- develop specifications for high density polyethylene netting materials;
- define tentative specifications for netting materials other than polyester and polyethylene; and
- reach consensus on the content of guidelines for quality control and procurement of mosquito nets.

* Long-lasting insecticidal nets (LLINs) are identified by the code LN in WHO specifications for these products.

** The meeting did not consider certain characteristics which are restricted to LLINs, as these are addressed through the WHO Pesticide Evaluation Scheme.

2. PHYSICAL CHARACTERISTICS OF NETTING MATERIALS FOR MOSQUITO NETS

In the 2000 meeting, three sets of specifications for netting material were discussed – for cotton, polyethylene and polyester, with a range of attributes and test methods proposed for polyester netting. However, as additional types of netting materials are being introduced into the market, the 2005 meeting recommended that generic minimum requirements for netting materials and mosquito nets should be developed. Producers can then develop materials that will possess the properties required of any type of netting.

Any mosquito net should comply with the following minimum attributes:

- protect against insect/vector entry;
- be strong and durable;
- keep its dimensions after washing; and
- be safe for users.

In addition, nets that are intended for treatment at the field level must be able to be treated correctly with an appropriate volume of insecticide formulation diluted in water.

Once these minimum attributes are met, the choice of netting material and nets is up to the buyers. Institutional buyers already include additional attributes in their tenders, e.g., size, colour, shape, doors, hanging rings and other net design and performance indicators, as appropriate to the intended application or local requirements.

3. MINIMUM GENERAL SPECIFICATIONS FOR MOSQUITO NETS

3.1 Mesh count

Available evidence for the efficacy of non-treated mosquito nets is mostly based on warp-knitted polyester netting, with a minimum mesh count of 156 (i.e. 156 holes per square inch). Although the holes in netting with this mesh count are usually neither round nor square, and may be somewhat irregular in shape and size, they have a diameter of about 2 mm and provide an effective barrier to most *Anopheles* mosquitoes. Netting with a mesh count of 196 (i.e. 196 holes per square inch) is commonly used for prevention of leishmaniasis, which is transmitted by sandflies that are smaller than mosquitoes. Netting for LLINs may have larger holes (e.g. 56 holes per square inch), because such netting presents both physical and chemical (repellent and killing) barriers, which are expected to remain effective throughout the normal service life of the net.

In the absence of an international standard method, mesh count is assessed visually with a Pick glass or other accurately calibrated rectangular template, or with a ruler. The assessment may be made directly on the material or by scanning/photocopying a measured square of the netting and counting the holes on an enlarged printout. Counting is facilitated by aligning one edge of the Pick glass or template with the holes in one dimension (e.g. lengthwise) and, if possible, aligning the adjacent edge with the holes at right angles (i.e. width wise), so that it is necessary to count only the holes on two sides of the square. Alternatively, complete holes can be counted along a ruler in the two directions of the fabric at a right angle, using a multiplication to arrive at surface area. Irrespective of the method used and the alignment or otherwise of the template, part-holes ≥½ are counted as complete holes, whereas part holes <½ are not counted. Errors in counting are likely to arise if the area counted is not square or rectangular. In practice most counting methods produce similar, but not necessarily identical, results.

Consensus was reached that, for protection against mosquito entry, the size of holes is more important than the number of holes per unit surface area. However, given the wide range of hole shapes in various fabrics and the absence of a standardized method for measuring the dimensions of holes of irregular shape, the 156 mesh count remains the quality specification for mosquito control for untreated or field-treated netting on condition that the netting has holes of reasonably homogenous size. As already indicated, because of their retention of insecticidal activity against mosquitoes, LLINs may have a different minimum mesh count, which may be product-specific.

Research requirements:

a. Determine the optimum shape and maximum dimensions of holes required to prevent mosquito entry through untreated netting.

b. Develop alternative, rapid and reliable methods for measuring mesh size, according to the optimum shape and maximum dimension requirements.

3.2 Bursting strength of netting materials

Strength of netting material can be measured as: (a) its *bursting strength* (the maximum pressure that can be applied to a given surface area of netting before it bursts under the strain); (b) its *tensile strength* (the strain applied to a material in various directions before it gives way); (c) *tear strength* (e.g., the weight can be hung from a small hole before the material tears); or (d) as a very crude measurement, by grasping the material in both hands and gauging the effort required to push the thumbs through it.

Bursting strength is currently the only practicable test for which reliable data exist. Netting quality has improved over the past 5 years and the meeting agreed that the minimum bursting strength for acceptable netting materials is 250 kPa, when measured according to ISO 13938-1 (1999) or ISO 13938-2 (1999), using a 7.3 cm^2 sample. Experience had shown that this corresponds approximately to the minimum which would satisfy a test using thumb pressure only, although the latter test is subjective and not suitable for testing for compliance with a specification.

According to the ISO standard, bursting strength can be measured on areas of netting material measuring either 7.3 cm^2 or 50 cm^2, though they do not give identical results. In 2000, 7.3 cm^2 was chosen for testing of netting materials. All available routine test data were derived from 7.3 cm^2 samples and, at present, there are no validated threshold limits for 50 cm^2 samples. A sample size of 50 cm^2 could be used for quality testing, subject to the availability of data to support a proposed threshold value.

Research requirements:

a. In a range of netting materials, establish the values obtained from use of a 50 cm^2 test head that correspond to those measured with a 7.3 cm^2 test head.

b. In a range of netting materials, establish whether or not the values obtained with hydraulic equipment (ISO 13938-1) are equal to those obtained with pneumatic equipment (ISO 13938-2).

3.3 Bursting strength of seams

Mosquito nets require seams in the netting material, to give the net the desired shape and to seal against mosquito entry between adjacent panels of fabric. For acceptable performance, the seams must be at least as strong as the netting. At present, there is no documented experience with standardized tension tests for seam quality control on mosquito nets. Therefore, the meeting proposed that the test for bursting strength should also be used to measure seam strength in the net. The equipment for testing bursting strength does not require modification for this purpose.

Research requirements:

a. Manufacturers should check that the relative bursting strengths of fabric and seams, measured by ISO 13938-1 or -2 (1999), correspond to the results obtained by any other test method used for assessing seam strength.

b. In a range of netting materials, compare the values obtained from testing seams with 50 cm^2 and 7.3 cm^2 test heads.

c. In a range of netting materials, compare the values obtained from testing seams with hydraulic equipment (ISO 13938-1) and pneumatic equipment (ISO 13938-2).

3.4 Dimensional stability

Current tests for dimensional stability are performed with a sample of the netting material treated according to ISO 3759 (1994) and ISO 6330 (2000) and the results are calculated according to ISO 5077 (1984) and expressed as percentages (usually shrinkage, though stretching may also occur). The 2000 WHO specifications state that shrinkage in either direction of the netting material should be no more than 5%. Most commonly netting material is heated and pulled into shape during the production process ("heat-setting") to achieve the correct mesh count but nonetheless nets can be sensitive to the temperature at which they are subsequently washed.

There are 10 European washing procedures (for front loading machines) specified in the ISO 6330-1984 (E) standard and 11 for the United States of America (for top loading machines). The revised WHO specification relies on the 8A wash procedure (European norm: gentle wash at 30 ºC) and drying procedure C (dry flat). For reproducible results, great care should be taken

during all steps of preparation and handling of samples, avoiding tension on the sample in any direction. The meeting noted that this laboratory test is not necessarily comparable to any of the many different procedures used under field conditions. However it does provide a standardized comparison between products and the limits proposed are based on data from products which have proven satisfactory in the field.

The meeting noted that acceptable dimensional stability criteria for netting may not be appropriate for nets, if there is a large (but otherwise within specification) difference between warp and weft shrinkage/stretching, because unacceptable puckering or wrinkling of the seams could occur.

Research requirements:

a. Information should be collected on the occurrence of unacceptable puckering or wrinkling of seams observed in practice, together with the corresponding test measurements of dimensional stability, to support a future review of the limits for this characteristic and of the possible need to include dimensional stability of the net itself in the specification.

3.5 Durability and storage stability

The durability of nets and netting materials is a very important characteristic for the user but there is a lack of simple tests which measure, or predict, resistance to the "wear and tear" arising from normal use. The most important criterion of durability is the retention of bursting strength for an acceptable time in normal storage and use. In principle, the bursting strength of all fabrics can be expected to decline over time, due to polymer degradation, and the rate of decline can be expected to be increased by handling, washing, drying, exposure to heat and light, etc. The meeting agreed that a test of "wear and tear" resistance is required and that it should measure how well bursting strength is maintained.

In the absence of an appropriate test of "wear and tear" resistance, the meeting considered the need for a test of storage stability. A well-established test of storage stability (CIPAC method MT 46.3[*]) is currently referenced in WHO specifications for LLINs and includes a requirement for maintenance of bursting strength after accelerated storage. The method has not been applied to untreated nets/netting but it simulates storage equivalent to approximately 2 years storage at room temperature. The usual test involves a

[*] Accelerated storage procedure. Pages 128–130. CIPAC Handbook, volume J. *Analysis of technical and formulated pesticides*. Collaborative International Pesticides Analytical Council, Harpenden, UK. 2000.

14-day continuous exposure to 54 °C, although a lower temperature may be applied for a longer time to products that are irreversibly damaged at 54 °C (testing at lower temperatures is unlikely to be necessary for untreated nets).

The rates of decline in bursting strength of currently available untreated netting materials are unknown. Anecdotal evidence, from field use, indicates that the strength of untreated polyester nets can decline to unacceptable levels within 2–3 years but this may be more due to "wear and tear" than to the simple effect of time. The meeting agreed that a minimum specification for storage stability may be required but that data are needed to ensure that the most appropriate characteristic is tested.

Research requirements:

a. Manufacturers of untreated netting materials should provide data to WHO on the bursting strength of their products, before and after a test of storage stability at 54 °C for 2 weeks (CIPAC method MT 46.3), to support a future review of the need to test this characteristic and for setting appropriate limits.

b. A simple standard test of fabric durability should be developed, to predict the impact on bursting strength of 2 years "typical wear and tear", involving a combination of washing, drying (shielded from direct sunlight) and storage at elevated temperature.

4. OTHER PHYSICAL CHARACTERISTICS OF NETTING MATERIAL FOR MOSQUITO NETS

4.1 Yarn composition

The choice of yarn is usually related to economic or comfort considerations, and should not be part of the WHO specifications. However, if nets are to be treated in the field, before purchasing nets made of a new type of polymer or fibre type, evidence should be obtained on the uptake of insecticide formulation diluted in water during dipping, and the retention of active ingredient thereafter.

4.2 Fabrication method

Evidence for the suitability of untreated or conventionally treated nets is currently only available for polyester warp-knitted[1] nets, which constitute most of the current market for institutional buyers. Warp-knitting makes the fabric "non-running", after minor damage, and this fabrication procedure has therefore been used extensively for both polyester and polyethylene nets.

Research requirements for non-warp-knitted fabrics:

a. Develop a simple standard test for resistance to shifting of the yarn (i.e., holes cannot be pulled out of shape and size).

b. Develop a simple standard test for elasticity (i.e., after stretching, the material quickly regains original size).

[1] The **warp**, or chain-loom, machine, generally flatbed, builds vertical chains, or wales, each having a separate yarn. The wales are tied together by zigzagging the yarns from needle to needle in the basic tricot or milanese stitches, or variants of these. A warp-knit fabric is run-resistant but less elastic than weft-knitted fabric. **Raschel** knitting is one type of warp knitting. In **weft** knitting, which includes hand knitting, the fabric is constructed in horizontal courses with one continuous yarn.
From http://www.bartleby.com/65/kn/knitting.html (accessed 8 December 2005).

4.3 Filament texture and filament count of yarn

Evidence (WHO unpublished results) indicates that texturization of multi-filament polyester yarn results in slightly higher water absorption (2 to 5 %) during field treatment with insecticide formulation diluted in water. Nets made from texturized yarn usually have the same range of bursting strength, a slightly lower shrinkage and a softer feel than netting made of flat or round yarn. Both materials are suitable for use in mosquito nets.

The number of filaments which the yarn is made influences physical characteristics of the netting: such as water uptake; the surface area to which insecticide can bind; and hence the final concentration of insecticide per unit area of net. The cross-sectional shape and surface texture of filaments also influence the same characteristics: flat, irregular-shaped and textured filaments have a greater surface area than round filaments of the same cross-sectional area.

In 2000, a minimum filament count of 36 was agreed for the yarn to be incorporated into polyester netting material. Netting made from polyester multi-filament yarn with filament counts above 30 has proven acceptable for insecticide treatment of nets at field level. Monofilament yarn is suitable for netting made of high density polyethylene. The meeting agreed that it was more important to ensure that the net absorbs the expected volume of insecticide formulation diluted in water, than to maintain 36 as minimum filament count.

Research requirements:

a. Further research should be undertaken by commercial partners on the relationship between filament count, physical strength and insecticide uptake, both at laboratory and at field level.

4.4 Linear density

Linear density is a characteristic of the yarn and is expressed in units of denier (grams per 9000 metres) or decitex (grams per 10 000 metres). Denier and decitex are a description of yarn, not a minimum characteristic of the netting, although the values influence the fabric weight per unit area. Linear density is difficult to measure in any type of finished netting product and impossible to measure in warp-knitted netting. The denier/decitex of yarn is one element contributing towards the bursting strength of netting but bursting

strength is a much more useful and practical overall measurement. Polyethylene nets are commonly made of higher denier yarn than polyester nets. Denier should thus be specified in tendering and included on the label but it should not be part of routine quality testing.

4.5 Weight of netting material

For a specific product (e.g., warp-knitted polyester netting), the weight (grams per square metre) of the final netting material is closely linked to denier of the yarn and to mesh count. Lighter netting material is cheaper. Weight is not included in the minimum specification for netting materials but it should be stated on the packaging of the net. When appropriate, weight should be measured according to standard ISO 3801 (1977), with preconditioning according to ISO 139 (2005) (4 h, 20 ºC, 65% relative humidity).

4.6 Fire safety

Flammability of nets and netting depends on the polymer used to produce the yarn and the application or incorporation of any additives, including flame retardants. The potential for dripping of melting polymer at high temperatures is also an important characteristic, because of the risks to eyes and skin: it is related to the yarn polymer and does not change from net to net. Flammability may eventually be affected by insecticide treatment but there is no evidence so far supporting this hypothesis.

Polyester is a flammability Class 1 material ("non-flammable") according to 16 CFR Part 1610. In a study on the flammability of netting materials, 10 samples of commercially available HDPE netting and 5 polyester samples were tested according to EN 1102 and 16 CFR Part 1610 (WHO, unpublished data). All samples were classified as non-flammable according to both standards. However, in a previous study of 8 samples of HDPE, 3 samples eventually ignited and dripped under EN 1102 conditions ("heterogeneous burn behaviour"), although all samples were classified as Class I ("non-flammable") according to 16 CFR part 1610.

Flammability should be determined by the manufacturer according to 16 CFR part 1610 but routine quality testing during procurement is not expected to be required.

Research requirements:

a. Additional investigations of burn behaviour and impact of flame retardants should be undertaken.

4.7 Air permeability

It was agreed that air permeability should not be included in the WHO specifications, as comfort is highly culture- and climate-dependent and, as yet, no study data are available on consumer preferences for air permeability.

Research requirements:

a. Industry should carry out research on comfort in relation to air permeability and moisture/vapour permeability of netting materials.

4.8 Water and insecticide uptake

Mosquito nets may be treated in the field by dipping in a dilution of insecticide formulation in water. To ensure correct dosing when nets are treated individually, the volume of diluted insecticide prepared should match the water uptake of the net, especially if an insecticide treatment kit is "bundled" with the net. If water uptake is unexpectedly high, parts of the net will not be properly treated, whereas if uptake is unexpectedly low, the dose rate may be too low and, as such the excess liquid must be disposed of safely. Water uptake of a net is influenced by the type of yarn used and its pre-treatment in the factory (e.g. addition of oils or other finishing products) and should be stated on the label and packaging of the net.

At present, only polyester netting made from fibres with a filament count of above 30 is known to provide the appropriate characteristics for insecticide treatment at field level, and thus can be recommended for this purpose. According to WHO, 0.5 litre of insecticide formulation diluted in water should be used to treat a polyester net and 2 litres should be used for a cotton net*.

* Instructions for treatment and use of insecticide-treated mosquito nets. WHO/CDS/WHOPES/GCDPP/2002.4, WHO, Geneva, 2002.

4.9 Pesticide bioavailability and retention in field-treated nets

Where nets are to be treated in the field, the netting material must provide adequate retention and bioavailability of the insecticide. Producers of insecticide treatment kits and sachets are already required, by WHOPES, to specify the types of fabric/net for which the insecticide dose is intended, as well as the expected wash resistance of the treatment and its duration. Current WHO recommendations are that field-treated nets should be retreated after three washes or at least once per year. Bioavailability and wash resistance of the insecticide on the net are key characteristics of the quality of insecticide treatment of nets in the field. The meeting noted that bioavailability, as measured by bioassay, is difficult to relate to analytical measurements.

5. GUIDELINES FOR PROCUREMENT AND QUALITY INSPECTION OF MOSQUITO NETS

Outline of content

Consensus was reached on the following outline for the content of *Guidelines for procurement and quality inspection,* which should be further elaborated, for use by national programme managers and other unaccustomed purchasers who do not benefit from the services of well-established procurement agencies. The guidelines should reference simple but well-proven testing methods, to minimize time and cost while providing reliable results. Following these guidelines and the WHO specification, purchasing authorities should be able to adequately manage the procurement, quality control and interpret test results.

5.1 Netting material

The fabric must comply with the WHO specification for mosquito nets. Some additional, application-specific, requirements may be defined by the supplier (e.g. number of filaments, type of fabric, weight). Nets for protection against other vectors may require specifications which are different from those adopted for mosquito nets.

5.2 Physical attributes of the nets

The product must comply with WHO specifications for mosquito nets. Net design and performance indicators should be specified, e.g. shape, size, colour, etc., according to local habits or the requirements of the application.

5.3 Reference samples

Bids for supply of nets must be accompanied by a reference sample of the nets which will be supplied. This reference sample must be comprised of at least two nets, one to be tested by the purchaser and one to be stored as a reference in case of disputes. Producers must deliver a uniform consignment which conforms to the reference sample.

5.4 Treated or untreated nets

The purchaser must decide whether or not nets are to be treated or untreated with insecticide, according to the requirements of the application. Where treated nets are required, the purchaser must decide whether to buy untreated nets for field treatment[1], untreated nets with insecticide treatment kit bundled, or LLINs. Procurement of factory-treated nets other than LLINs is not recommended.

5.5 Labelling

On the net: size; name of manufacturer; brand name; fibre composition; water uptake per net (if intended for treatment in the field). Standard pictograms for washing should also appear on a label attached to the net. There should be 5 pictograms (according to ISO 3758) indicating: gentle wash at no more than 30 °C; no bleaching; no use of a drying machine; no ironing; and no dry cleaning.

The same information should appear either on the bag, or as a leaflet inside the bag, with the following additional information: filament count; fabric weight (grams per square metre); linear density of fibres; flammability; use, care and washing instructions, with illustrations, in addition to any other information required by national regulations.

5.6 Information related to the insecticide intended for field treatment other than long-lasting insecticide treatment kits

The label of the insecticide container must bear: the name of the manufacturer; the identity of the active ingredient; the concentration of active ingredient; the formulation type; the intended dose of active ingredient per square metre of netting when applied to a defined net; expiry date of the formulation; an instruction that the treatment must be repeated after three washes of the net or at least once a year; hazard warnings and safety instructions; national registration information; reference to the WHO specification for the formulation; the manufacturer's statement of compliance with the WHO specification for the product.

[1] NB: at the moment only polyester nets are known to provide the appropriate characteristics for insecticide treatment at field level. Thus, at the moment, only polyester can be recommended for this purpose.

5.7 Packaging of bales of nets

The purchaser must define any requirements for maximum/minimum size, labelling, weight, number of nets per bale, etc.

5.8 Procurement process

It is essential to define: the required place(s) and date(s) of delivery; the required time scale between order and delivery; the intended inspection of manufacturer's premises and quality control (if required); national registration requirements, including notification for imports; the requirement for a uniform consignment conforming to the reference material/sample; the requirements for the manufacturer's evidence of conformity with the reference sample; the arrangements for sampling and testing required for the purchaser's quality inspection programme, etc.

5.9 Quality inspection

The scope, sampling procedures and number of samples, acceptance and rejection criteria, etc, of the purchaser's quality inspection programme must be defined. The costs, time delays and risk implications of the quality inspection will be borne by the buyer and should be kept in mind when developing a quality inspection programme. The appropriate balance between costs and risks cannot be defined because both factors may involve many components which will be weighted differently in different situations.

WHO specifications define the minimum criteria for distinguishing between good and bad products; therefore nets should be tested for compliance with all specified clauses and limits. Omission of the more expensive or time-consuming tests from the quality inspection process may appear to be financially attractive but increases the risk of accepting poor quality nets or netting, and is therefore not recommended.

5.10 Sources of information

Information on mosquito nets, insecticides and LLINs, their characteristics, applications, specifications, prices, etc., is available from many different sources, for example http://www.rbm.who.int/mmss/.

5.11 Actions to consider

a. Use of procurement agency services, for instance, from the UN system or others.

b. Planning and management of the procurement process, so that all activities and actions are undertaken by the correct persons, at the correct time, and with the correct organizations, to avoid delays and mistakes.

c. Management of shipment/delivery, customs clearance, etc.; management of distribution, storage, field treatment (if appropriate) of nets after delivery, so that all activities and actions are undertaken by the correct persons, at the correct time, and with the correct organizations, to avoid delays and mistakes.

6. UPDATED WHO SPECIFICATION FOR NETTING MATERIALS AND MOSQUITO NETS

6.1 Description (refer to note 1)

The product shall be in the form of a net of …[conical, rectangular, etc,] shape, having dimensions of …[dimensions in metres]. It shall be made of netting, consisting of …[denier/decitex, mono-/poly-filament, polymer type] fibres. The product shall appear clean and shall be free from visible extraneous matter, 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), and shall be suitable for use as a mosquito net.

6.2 Physical properties (refer to notes 2 & 3)

6.2.1 Mesh count (note 4)

When counted by the method given in Note 4, the average number of complete holes/in^2 shall be not less than 156 and the lowest value shall be not less than 148.

6.2.2 Bursting strength (note 5)

The minimum bursting strength of the fabric shall be declared (not less than 250 kPa[1]) 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 average for the fabric.

6.2.3 Dimensional stability (note 6)

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

NOTE 1

Other characteristics (colour, number of filaments in the yarn, filament texture, etc.) may be specified separately, according to the requirements of the application.

NOTE 2

Nets should be tested for compliance with all clauses in the specification. The number, frequency and distribution of nets, within and between batches/consignments, to be

[1] KiloPascal: a unit of pressure. 1 kPa is approximately the pressure exerted by a 10-g mass resting on a 1 cm^2 area – 101.3 kPa = 1 atm.

tested by the buyer for compliance with the specification must be decided by the buyer, according to the required balance between cost and risk. Risk depends on the probability (or frequency) of non-compliant nets occurring within a batch/consignment. A method for determining sampling frequency based on probability is given in Tables 1a and 1b, page 19.

NOTE 3

Samples for testing physical properties should be taken from nets according to figure 1, page 20. Samples must be sufficiently large to conduct all tests required and be representative of the net. Except where seams are to be tested, do not test material within 10 cm of seams or selvedges. Where a net is made from more than one type of netting, each type of netting should be sampled and tested separately.

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

NOTE 4

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 scanning/photocopying the fabric. Indirect methods may ease counting and provide a permanent record. Before scanning/photocopying or counting directly, the fabric should be conditioned according to ISO 139 (2005) (4 h, 20 ºC, 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 rigid sheet, 1–2 mm thick, in/on which a calibrated (±1% in each dimension) square (e.g. 1 x 1 in or 2 x 2 cm) has been accurately cut/marked. Alternatively, a Pick glass may be used. 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, at least one edge of the square to be counted should be aligned with a row of complete holes in the fabric. Incomplete holes ≥½ are counted as complete holes, whereas those <½ are not counted. Count 5 replicate squares in pieces taken according to Note 3, calculate the average and note the lowest value.

NOTE 5

Test method: ISO 13938-1 (1999) or ISO 13938-2 (1999), with conditioning of the fabric according to ISO 139 (2005) (4 h, 20 ºC, 65% relative humidity). The declared minimum bursting strength, and testing for compliance with it, should be based on tests of 7.3 cm^2 areas of fabric. Proposed specifications based on tests of 50 cm^2 area must be supported by data showing the suitability of the proposed value and its relationship to the minimum of 250 kPa (which is based on 7.3 cm^2 area). Five replicate tests should be conducted on samples taken as described in Note 3. 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 a 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 6

Method of preparation before and after the washing test: ISO 3759 (1994). Method of washing: ISO 6330 (2000). 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, horizontal drum). Washing programme: ISO type 8A (gentle cycle 30 ºC). Fill the washer with ballast/dummy load (with fabric as per ISO standard) up to the standard of 2 kg. Detergent: IEC + sodium perborate. Drying: C, flat drying.

Table 1a: **Sampling rate based on probability of detection and frequency of non-compliance**

	Minimum number of samples per batch required to detect a non-compliant net with a probability of:		
Actual frequency of non-compliant nets in the batch	90%	95%	99%
20%	11	14	21
15%	15	19	29
10%	22	29	44
5%	45	59	90
1%	231	299	459

Example: A buyer aiming for 90% confidence to detect a non-compliance occurring at 10% frequency would have to collect and test 22 nets per batch.

Table 1b: **Example: the probability of detecting a non-compliant net by testing 8 nets per batch**

Actual frequency of non-compliant nets in the batch	Probability of detecting a non-compliant net by testing 8 nets
44%	99%
31%	95%
25%	90%
10%	57%
5%	34%
1%	8%

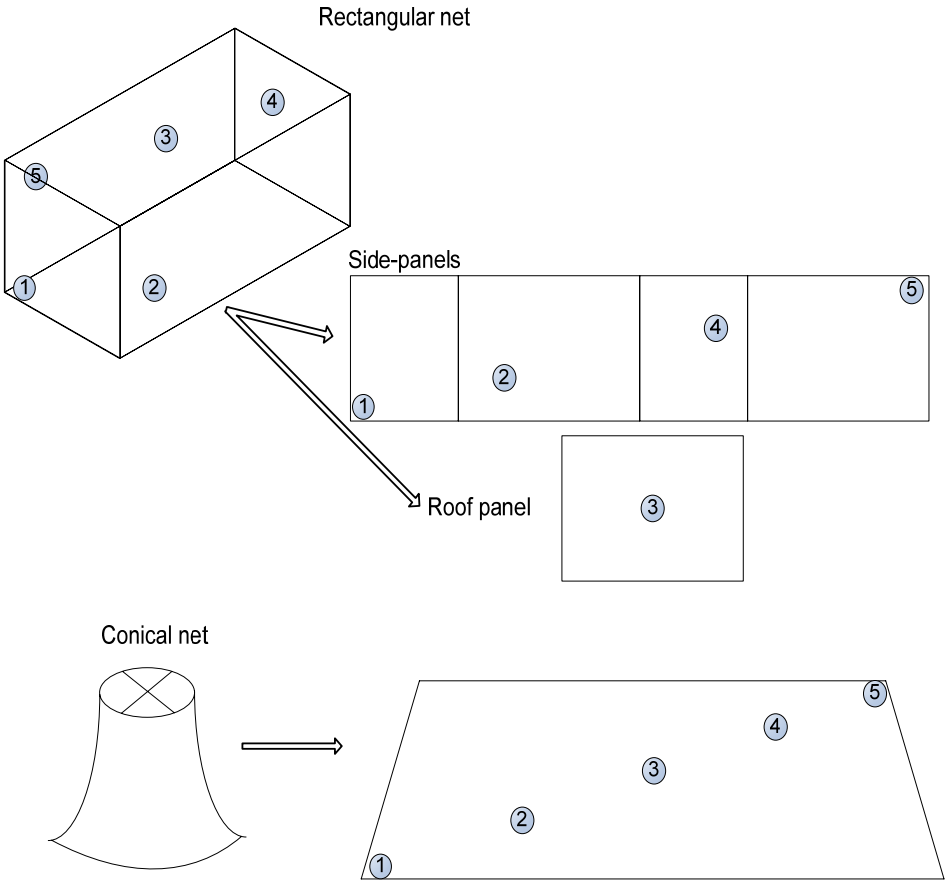
The probability values given in Tables 1a and 1b assume either random sampling or a random distribution of non-compliant nets, or both. The values are calculated from:

$$1–p = (1–i)^n$$

where: p = probability of detecting a non-compliant net (expressed as a fraction, not %);
i = incidence of non-compliant nets in the batch (expressed as a fraction, not %);
n = number of nets tested from the batch.

Figure 1. Sampling for testing for compliance with the specification.

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



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