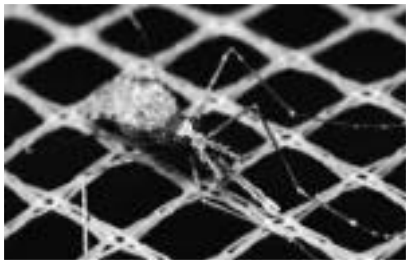
ROLL BACK MALARIA

Specifications for



# NETTING MATERIALS

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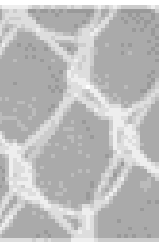
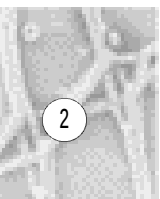


*Part 1*

# The importance of setting specifications for netting materials

## 1. Introduction

Insecticide-treated nets (ITNs) are an important component of current efforts to Roll Back Malaria (RBM) since, in addition to developing new cost-effective interventions, RBM intends to make existing tools, including ITNs, more widely available. ITNs are known to protect against a range of vector-borne diseases (leishmaniasis, filariasis, as well as malaria) and can reduce overall childhood mortality by about 20%. They are therefore seen as one of the main tools of achieving RBM's objective of halving the world's malaria burden by the year 2010. RBM strategy calls for a 30-fold increase in the purchase and use of ITNs, especially in Africa.

Among RBM partners USAID has already initiated the "NetMark" project in Africa and UNICEF has established support systems targeting country-level ITN interventions. RBM is now catalysing the development and strengthening of global, regional and country-level partnerships among governments, the private sector, UN agencies and NGOs in order to support ITN implementation.

RBM's strategy for ITNs emphasises the importance of compliance (regular use) and re-treatment. Retreatment issues, the need to move from efficacy (well-established through several randomised field trials) to large-scale implementation; and developing technical guidelines are among the main challenges to "going to scale"—making ITNs available, affordable and sustainable. WHO will support ITN implementation research, further develop insecticide-treated materials and investigate related aspects such as pyrethroid resistance (mechanisms, dynamics and impact).

To achieve RBM's objectives, a mosquito net culture in which owning ITNs and using them properly is the social norm, has to be created, especially in Africa. Expansion of a mosquito net culture to national scale will require partnership between the public and private sectors in which the public sector must reduce taxes and import tariffs, ensure standards, promote the use of ITNs and ensure protection of high-risk groups, while the private sector must advertise the product, create and meet demand through producing, wholesaling and retailing nets. ITNs are currently sold and distributed through the public sector (governments), the private sector and a mixture of the two (governments, international organisations and NGOs). ITNs might be distributed free (e.g. by NGOs in emergency situations), subsidised, or with full cost recovery (e.g. China, Gambia).

Although a large number of bednets have already been purchased globally by various institutional buyers—NGOs or other agencies such as UNICEF, UNHCR and WHO belonging to the UN system— there is as yet no consensus on specifications for netting materials and, as a result, it is difficult for buyers to compare offers and control quality. It is also difficult for manufacturers to cope with the requirements of separate agencies who request different, sometimes conflicting, specifications. Setting minimum specifications for bednets will also help to promote quality products, which is likely to improve their community acceptance.

## 2. Role of ITNs in disease prevention

The use of ITNs has been shown to be very cost-effective and resulted in a 20% reduction in overall child mortality in Africa, equivalent to six deaths averted per year per 1000 children protected, at a cost of about US$ 5 per child. A total of 80 million children in Africa are currently at risk, and the use of ITNs would prevent 480,000 deaths per year. A meta-analysis

showed that under stable malaria transmission (EIR<1) in Africa and PNG, ITNs provide 46% protection against *Plasmodium falciparum* and under unstable transmission in Asia and Latin America, they provide 60% and 45% protection against *P. falciparum* and *P. vivax* respectively.

In holoendemic areas of Africa, it is not yet entirely clear whether ITNs provide personal protection to users or mostly protect communities through a "mass effect" on the population size and lifespan of mosquitoes. In some areas (especially in West Africa), pyrethroid resistance is already at high levels and to what extent this might reduce the impact of ITNs is not yet known.

### 3. Prospects for use of ITNs in Africa

The task of scaling-up of ITN use from trial (efficacy) to national level (effectiveness) is a difficult one. In 1998 WHO started providing technical and financial support to popularise ITNs. Three intercountry workshops have already been organised by the WHO Regional Office for Africa (AFRO) to prepare national action plans to promote large-scale use, and 30 countries have attended. WHO will now concentrate on monitoring and evaluating country programmes.

In February 1999 a consultation was organised to develop the necessary tools and indicators for monitoring such programmes. ITN promotional activities are currently being assessed in five countries, and by the end of 2000, 20 countries will have been assessed (with recommendations for discussion during future workshops). In the five so far reviewed, 30-60% of households had at least one net, but only 13% of nets were treated and less than 5% had been retreated. Most of the time, treatment took place at fixed treatment centres, and this seems to contrast negatively with the household dip-it-yourself approach developed in East Africa. This monitoring data will be used to sensitise African leaders to some of the challenges to the concept of "going to scale" with ITNs.

### 4. Why having specifications for netting materials is necessary

Specifications exist primarily to protect and benefit consumers. However, certain qualities are culture-specific, and attempts to standardise colour or shape, for example, are undesirable. Neither WHO, UNICEF or any other agency should see themselves as final arbiters in such matters; that is for the user, and market forces or social marketing may lead to a broad range of net sizes, shapes and colours. However, at the moment, some standardisation on size makes procurement simpler for institutional buyers. While social research on preferences is needed, there is insufficient time when needs are pressing, for example in emergency situations. In the longer term, social research for the procurement of acceptable nets will prove to be essential for community-based interventions.

Criteria to define netting materials are as essential as quality control. Test methods and standards should meet ISO (International Standards Organisation) criteria. First it must be defined what the material is expected to do, then the necessary parameters or criteria must be selected, the specification range or limits must be set, and then the test method decided upon. For institutional buyers, the criteria is to provide long-term protection against malaria and other vector-borne diseases. For the consumer, it is to provide protection against mosquitoes.

Standards are also essential for quality control, and will lead to general improvements in manufacturing quality. Standards would also help institutional buyers and new manufacturers entering the market. Good quality, large nets are now available at low cost (less than $3) and poor quality does not necessarily mean cheaper. The cost of good quality nets is not higher especially when taxes, transportation and finishing (tailoring) have been included.

It has been suggested that standards and labelling should show whether a product has been treated with insecticide or not. However this must be done within reasonable limits, since

insecticide formulation and dosage involves many complex issues concerning efficacy, life-span, and safety. The current development of long-lasting nets treated at factory level and their likely implementation in the near future might reinforce the need for specific labelling for insecticide treatment.

Low re-treatment rates are seen as one of the main arguments for the development of long-lasting nets. The low coverage of ITNs might be increased if current efforts to have taxes and tariffs waived on nets and insecticides were successful.

## 5. Interactions between fabrics and insecticide formulations

The interaction between insecticide and fabric is complex and difficult to predict. Laboratory and experimental hut studies have explored relations between fabric, insecticide, formulation, dosage, and effect. Durability varies on different fabrics. Pyrethroids are equally active on polyethylene, nylon, and polyester. However with polyethylene, activity usually fades more rapidly with time and washing.

Permethrin has been tested at 200 mg/m$^2$ on different netting materials (polyester, polyethylene, polypropylene) in experimental huts in Tanzania. There was no significant difference in efficacy in the field between different materials.

Insecticide concentrations on nets decrease by 30 to 50% on most netting materials after the first wash using SDS detergent. Loss was lower for subsequent washes. On multifilament polyester netting, insecticide loss was slower with CS (micro-capsule suspension) and EW (emulsion oil in water) formulations than with EC (emulsifiable concentrate). CS and EW lasted better on cotton and polyester than on nylon. In conclusion:

- There is still a shortage of reliable comparative data on the interactions between fabrics and formulations both in laboratory and field conditions. More research is needed.
- Although there is no strong evidence for one material over another, multifilament netting seems better (and is more comfortable).
- Water-based formulations seem to be more wash-resistant than EC formulations.

## 6. Netting materials

Netting materials used so far for mosquito nets have been polyester, polyethylene, nylon and cotton. Other materials such as polypropylene are currently developed and new materials or mixed fibres will be soon available.

**6.1 Cotton and polyester:** Cotton mosquito nets are traditionally and currently being used in several countries: the largest ITN programme in the world in Southern China is using cotton nets. Minimum specifications for cotton fabric must therefore be developed. In the absence of the required expertise, the meeting recommended further investigations with the aim of developing appropriate minimum requirements. However, polyester does have many advantages over cotton: it is more durable, gives more ventilation and there is less insecticide loss within the fibres. Polyester is usually cheaper, obtainable in larger consignments, has better quality control, and is more popular.

**6.2. Polyethylene:** Most polyethylene manufacturers produce monofilament netting though polyfilament is also available. Polyethylene 100 denier is equivalent to polyester 75 denier, and is the minimum standard. However it breaks down more readily when exposed to sunlight. Where importing other netting materials is difficult, polyethylene might be an alternative. A 150 denier polyethylene net with permethrin incorporated into fibre has been field tested in various places throughout the world. In West Africa, after four years of continuous use in villages from Senegal, more than 50% of the nets were still in a good shape (without holes) and, as shown in Côte d'Ivoire, this material was very much appreciated by villagers.

**6.3. Polyamide/nylon** was once used for nets but has now been replaced by polyester. By comparison, it is easily soiled, attracts dust, is less UV resistant and deteriorates much faster than polyester. Although Polyamide/nylon is still available in some places in Africa (imported or sewn up locally), nylon is not regarded as a suitable netting material.

**6.4. Polypropylene:** Although polypropylene nets are being developed, there is no information available so far on this material.

## *7. Quality of nets*

The quality of nets is important since people do not want to use poor quality nets and good quality nets are more durable without being significantly more expensive.

Quality is even more important if the net has not been treated or retreated with insecticide. In such cases, a better quality net will provide better protection. If a net has been properly treated with a pyrethroid, the insecticide will make even a bad or holed net an effective tool. This has been shown in trials in both Africa and Asia.

In Africa and other places where transmission is intense, it is not so much the net as the insecticide that provides protection against malaria vectors. In such conditions the quality of the net is less critical; making sure the net is treated with insecticide is more important. However, the quality of the net is also very important in terms of acceptability by users and product life.

In Asia and other places where transmission is less intense, it is the net more than the insecticide that provides protection. In such conditions, untreated and treated nets might give relatively similar protection, provided the nets are good quality and properly used. However, if the net is of poor quality or holed, treatment is needed to provide protection.

In conclusion:

- In Africa, insecticide treatment is important all the time.

- In Asia, insecticide treatment becomes more important if net is of poor quality, or if it ages or deteriorates.

## *8. Other insecticide-treated materials*

Textile materials different from nets might also be treated with good effect:

**8.1. Curtains:** Pyrethroid treated curtains have significantly reduced malaria morbidity and overall child mortality in Burkina Faso and Kenya.

**8.2. Tents:** Spraying inner surfaces with permethrin or deltamethrin for vector control was effective against indoor resting mosquitoes.

Treated tents are particularly suitable for refugees or nomads as they provide community protection. Permethrin-treated tents gave 60-80% protection against *P. falciparum* malaria in Asia although they have not yet been tested elsewhere.

**8.3. Treated clothing and bedding:** Randomised placebo-controlled household trial of permethrin 25/75-treated *chaddars* (headscarves) and top-sheets in an Afghan refugee camp gave 62% protection against *P. falciparum* and 46% against *P. vivax* for three months (but ITNs protect for 6-12 months).

In conclusion these materials are:

- Suitable for emergencies and disasters, e.g. refugees under temporary shelters may be provided with treated blankets.

- Cost-effective (outlay on insecticide only, not on nets), fewer logistical problems.

■ Suitable for families who are unable to afford bednets.

■ Still under development—need to be tested in other regions.

■ Protecting efficiently against cutaneous leishmaniasis (equal protection to that of nets in household intervention in Kabul).

■ Permethrin 25/75 treated clothing has provided protection to soldiers of several armies when based or on operations in tropical areas.

### *9. Long-lasting insecticide-treated nets*

Availability of an effective long-lasting insecticide treatment for netting materials that can last for the life-span of a net would be invaluable for a number of reasons, including:

■ low retreatment rates are the major obstacle facing ITN programmes in Africa;

■ net users do not perceive the need for retreatment (or are inadequately informed);

■ the dipping procedure is not simple;

■ insecticides are commonly unavailable or too expensive;

■ treatment centres are not operational or unsustainable.

Long-lasting treatment would have further advantages: handling of insecticide products would be restricted to professionals at factory level and release of insecticide into water bodies during washing would be minimal, thus reducing potential environmental impact.

Finally, long-lasting treatment may reduce insecticide consumption by up to four-fold, and would make it more affordable. Experimental hut and large-scale field trials are planned with two commercially available long-lasting nets: one made of polyethylene, the other made of polyester multifilament. One is currently no more costly than a net treated by regular dipping.

Several manufacturers are currently involved in the development and production of long-lasting insecticide treated nets and treated fabrics that resist more than 50 ISO normalised washes at 60°C are now available. Specifications for long-lasting, wash-resistant nets will be developed as soon as field trials are completed.

### *10. Conclusion*

Consensus was reached on the need for specifications for netting materials. Knitted polyester multifilament is regarded as the best material currently available on the market. Most experience has been acquired with this material and all net manufacturers present at the meeting were mostly, if not exclusively, using it. A set of minimum interim specifications was discussed and agreed upon, as well as ISO norms and standard test methods for quality control.

Specifications are important so that manufacturers and suppliers can ensure quality products and buyers are not confused. Too wide a choice can cause significant delays or difficulties if the donor requires several quotations and bids have to be compared for products with different specifications.

Specifications for cotton and polyethylene have not been proposed since they are either natural and not standardised (as in the case of cotton) or there has not yet been sufficient experience with them to draw up specifications (polyethylene). Consultations between institutional buyers (including WHO, UNICEF, and UNHCR), net producers and textile specialists will be intensified to gather information on other netting materials.

Collaboration with technical textile institutes such as British Textile Technology Group (BBTG, UK), Centro Technologico das Industrias Textil e do Vestuario (CITEVE, Portugal) or

Institut Textile de France (ITF, France) will be further pursued with the following objectives:

1. To validate interim specifications adopted for polyester.

2. To propose alternative criteria, specifications and testing procedures, if needed.

3. To compare the test quality of various net products currently available on the market and disseminate results widely, especially within the UN system.

4. To develop specifications for non-polyester netting materials through comparative tests.

5. To identify WHO Collaborating Centres or Institutions for technical advice on netting materials and quality control.

New materials of improved quality (strength, comfort, fire safety) will soon become available and it is essential that specifications be updated and/or developed accordingly. Bednets by themselves, as far as shape, size or colour are concerned, cannot be submitted to specifications. Institutional buyers may have to adopt some standards in order to facilitate procurement, manage stockpiles and ensure rapid delivery of nets. However, it was unanimously agreed that mosquito nets will have to be designed according to the habits and preferences of end-users and driven by market forces. Such adaptation will be essential to achieve better acceptance, compliance and sustainability. Every effort will also have to be made with the active involvement of social scientists to better understand the habits and preferences of users. The private sector will have a critical role in creating a "net culture" in Africa and elsewhere.

Interim specifications for polyester, as well as any specification on other netting materials, when obtained and agreed upon, will be made available to interested parties through the WHO RBM Web site (www.who.rbm.int).

*Part 2*

# Existing specifications applicable to netting materials

## 1. Introduction

Within the range of natural and artificial fibres that can be used for mosquito nets, polyester is by far the most common. Traditionally, minerals biocides could be added before spinning but not organic ones because heat treatment destroys the biocide. Three main types of polyester materials are currently available: non-woven (e.g. for surgery stitching), woven and knitted textiles.

Since yarn cannot be extracted from a knitted netting for further analysis, it is impossible to measure denier and tenacity from knitted materials. These two parameters can only be measured during production (Dupro) and before knitting. Denier is the standard measure, defined as mass of 9,000 metres of yarn. The international unit is Decitex, the weight in grams of 10,000 metres of yarn. Crimping of yarn is a qualitative term. Crimped yarn produces a texturised material which is usually more comfortable (see photo).

In general discussions, the relevance of the different parameters was examined. Bursting strength was considered a good measurement of strength. Others methods exist, such as measuring tear resistance (nail test) which could be more relevant to field use and net longevity, and easier to implement. There is a need for further investigations into parameters. Flammability is important for safety, permeability for comfort.

## 2. Fibre composition

Can be determined by:

1. Observation of filament by microscopy.
2. Using infra-red methods.
3. Dissolving in solvent (main method, ISO standard 1833).

## 3. Air permeability

Standardised pressure. Result are expressed in litre/$m^2$/second; ISO 9237.

## 4. Tear resistance

Use dynamometer or insert nail and apply standard weight. Alternatively use the pendulum method. Force is measured in Newtons. ISO 4674-2.

## 5. Bursting strength

Diaphragm method. The netting sample to be tested is clamped over an elastic diaphragm and increasing pressure is applied to the underside of the diaphragm until the specimen bursts. Result is given in Pascal or KiloPascal (KPa). ISO 2960.

## 6. Flammability

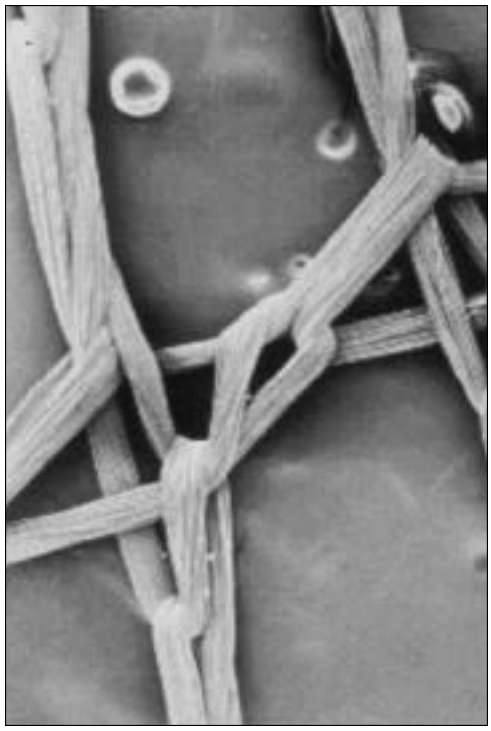
Propane flame applied for one second to fabric held at fixed angle. The result is the time of flame spread along distance D. CPSC (US) 16 part 16-10-cs 191-53.

Class 1: $t > 7s$

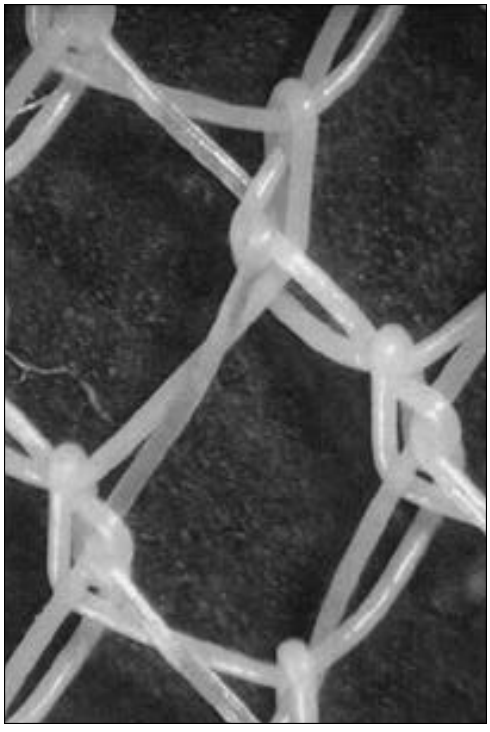
Class 2: $t = 4s$ or $< 7s$

Class 3: $t < 4s$

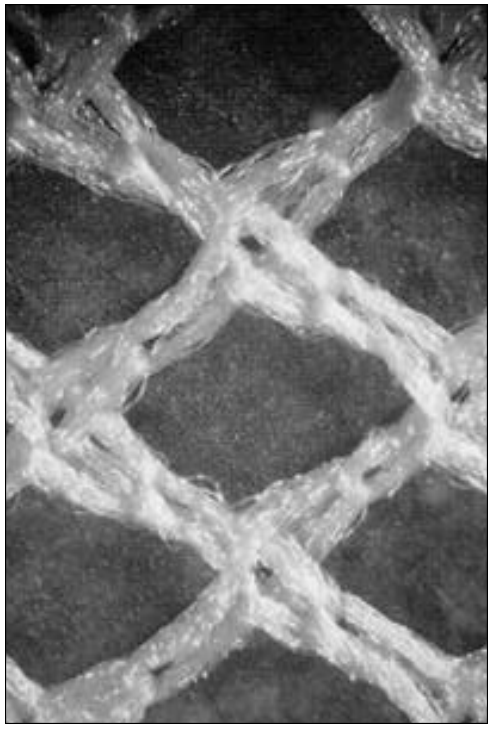
*Cotton*



*Polyester*



*High-density polyethylene*



*Texturised polyester*

## 7. Minimum specifications for polyester

**Composition:** Warp knitted multifilament polyester netting (36 to 48 filaments depending on denier). Analysis of fibre should be according to standards (ISO 1833, Fibre analysis method) on request (optional). Analysis also by infra-red or flame methods. UNHCR request fibre analysis for any new manufacturer they have not dealt with before, and use inspection companies with their own laboratories.

**Texturisation:** was considered not important to specify, and may not be apparent after heat setting, or crimping, anyway. UNICEF insisted on heat-setting, otherwise the material shrinks with washing. Confirmation of shrink-proofing is considered more important and relevant to general use than heat setting specification; the shrink-proofing ISO test compares size before and after washing. Shrink-proofing is non-specific and, unlike heat-setting, can also be applied to cotton fabrics. There was no objection to including heat-setting in the specifications. Test uncertainty is usually included within description of ISO methods.

**Mesh size:** minimum acceptable is 156 mesh (number of holes per square inch), corresponding to 25 holes/$cm^2$. Smaller mesh size (196 or 272) might be requested depending on local habits (Cambodian forest workers e.g. prefer 196 mesh as well as 75 denier, see below). It is understood that nets have to be treated with insecticides. Mesh 156 is suitable for mosquitoes but not for smaller vectors such as sandflies if netting is not treated (ITNs are more and more regarded as an effective tool for the prevention of leishmaniasis).

**Denier:** 100 denier is optimal (weight in grams of 9,000 m yarn). On request, Dupro (during production) test for denier can be done at factory level by inspection companies.

**Weight:** is derived from denier (e.g.100 denier = 40 g/$m^2$) and has the advantage of being measurable in the field on final product.

**Tenacity:** an alternative to tensile strength. Neither parameter can be verified since fibre cannot be extracted from knitted fabric. Dupro testing is possible during manufacturing process.

**Bursting strength:** correlates with tenacity and can be measured on the final product. This parameter was generally preferred. The minimum specification of 405 KPa was considered low by some committee members; it might be affected by treatments (i.e. EC insecticide formulation), or might change with age.

**Tearing strength:** nail test might be useful in field situations (ISO 4672-2). Tensile strength and tenacity are a property of the fibre, while bursting strength and tearing is affected by the net's weave.

**Shrinkage:** was recognised as important (ISO 6330). A parameter that might be more suited would be dimensional stability (ISO 5077). Both would have a tolerance below 5%.

**Fire safety:** Several specifications and test methods exist. Flammability (burn rate) is not the sole concern since toxic gases are also produced when burning some fabrics and these differ between materials. WHO will seek more information on inhalation toxicity. No fire retardant is normally added to polyester. Polyester is Class 1 in the American test; to raise the specification to Class 3 would require the use of retardant and this would double the price of the net. No member of the committee had heard so far of an accident involving burning polyester nets. It was recommended that an investigation into whether fire safety properties are stable over time should be undertaken.

| Polyester Netting | Threshold value or range | ISO Standard |
|---|---|---|
| Warp knitted | | 8388 |
| Multifilament | Minimum 36 | Not available |
| Mesh size | Minimum 156 holes/inch$^2$ | Not available |
| Fibre analysis (optional) | 100% polyester | 1833 |
| Denier (optional) | 100 or 75 | 2060, Dupro |
| Dimensional stability | Shrinkage less than 5% | 5077 |
| Weight (gr/m$^2$) | 100 denier: 40 g | |
| | 75 denier: 30 g | 3801 |
| Bursting strength (KPa) | 100 denier: minimum 405 | |
| | 75 denier: minimum 220 | 2960 |
| Fire safety* | 16 | (CFR 1610-CS191-53) |

* ISO 6941: 1984 Textile fabrics—burning behaviour—measurement of flame spread properties of vertically orientated specimens.

It is understood that figures in this table are minimum requirements. A net producer might be requested to produce nets, e.g. with a smaller mesh (196 or 272 instead of 156) depending on local habits or specific requirements from countries. In this case, weight and resistance (bursting strength) will necessarily be higher than the minimum threshold value.

### 8. Other tests related to strength and possible duration

Further testing will be needed to determine whether bursting or tearing strength is the most representative test or whether both should be included. Several ISO standards are available for tear resistance: ISO 9290 (1990 Textiles—determination of tear resistance by the falling pendulum method), ISO 9073-4 (1997 Textiles—test methods for non-woven Pt 4) and ISO 4672-2 (tear resistance with nail test).

### 9. Minimum specifications for cotton

The committee did not have the expertise to set the parameters since none of the manufacturers present produced cotton nets and cotton is a natural product with highly variable quality. Cotton manufacturers were invited to the meeting but did not attend.

Cotton mosquito nets are traditionally and currently being used in several countries. The largest ITN programme in the world, which is taking place in China, uses cotton nets. Therefore minimum specifications for cotton fabric do need to be developed. In the absence of the required expertise the meeting recommended further investigations with the aim of developing appropriate minimum requirements.

Notwithstanding this, polyester does have many advantages over cotton. Polyester is more durable, provides more ventilation, has less insecticide loss within the fibres, is usually cheaper, obtainable in larger consignments, better quality control and is more popular.

| Knitted cotton | Threshold value or range | ISO Standard |
|---|---|---|
| Mesh size | Minimum 156 | |
| Fibre analysis | To be specified* | 1833 |
| Denier | No denier | |
| Dimensional stability | Shrinkage less than 5% | 6330 (CFR 1610-CS191-53) |
| Weight (g/m$^2$) | 50 | |
| Bursting strength (KPa) | | |
| Fire safety* | | (CFR 1610-CS191-53) |

* Netting available with mixed fibres cotton-polyester

### 10. Minimum specifications for polyethylene

| Knitted high density polyethylene netting | Threshold value or range | ISO Standard |
|---|---|---|
| Mesh size | Minimum 156 | |
| Fibre analysis | 100% high density polyethylene | 1833 |
| Denier | 100 | 2060, Dupro, optional |
| Dimensional stability | Shrinkage less than 5% | 6330 |
| Weight (g/m$^2$) | | |
| Bursting strength (KPa) | | |
| Fire safety | 16 | (CFR 1610-CS191-53) |

Other specifications for polyethylene require further investigation.

### 11. Specifications for other materials

**Nylon Polyamide (nylon):** Formerly used but has now been replaced by polyester.

**Polypropylene:** No information available so far on this material.

*Part 3*

# Net design, labelling and packaging

## 1. Introduction

Although the main objective of the meeting was to adopt minimum specifications for netting materials, some discussions were raised concerning nets themselves. It is important for institutional buyers to better define the type of nets they would wish to purchase on request from users and Malaria Control Programmes. It is also important for net producers to know which type of nets will be purchased. However, it is recognised that, in the long run, the type of nets (material, size, colour etc) should primarily result from end user's choice and demand and should be driven by market forces.

## 2. Size

Discussions were raised about bednet size and its possible standardisation. For institutional buyers, standardisation would simplify tendering, purchasing and stockpiling. However, in practice size is a matter of user preference and culturally determined. One of the main lessons from previous projects is to "adapt the net to people, not expect people to adapt to the net". However, some common trends have emerged.

In some places a height of 150 cm is well accepted for rectangular nets although in others, such as West and Central Africa, people much prefer and demand higher nets (e.g. 180 cm). A length of 180 cm is also accepted, but in many countries beds are longer than this and 200 cm long would be easier to use and better accepted. The most popular widths (manufacturer's sales rates) are 130 cm and 190 cm, while 70 cm and 100 cm are not so popular in Africa. The names often given to these sizes (single, double, family, X-family) change from one manufacturer to another and are therefore considered misleading and have been rejected from any specification. Dimensions (width, length, and height) should always be quoted in centimeters to avoid any confusion during ordering.

It was strongly recommended that appropriate social research should be undertaken in each African country and among major ethnic groups to assess preferences (size, shape, colour) before placing large bednet orders. WHO, UNICEF, NGOs or social marketing or customer research organisations might be commissioned to undertake such studies. In the long run, such activities should be taken over by private sector as part of their promotional activities. Again, between net sizes of 12 to 15 $m^2$, there are no major cost implications and the most critical parameter for an effective and sustained use of ITNs is the satisfaction of users.

For conical nets, the following sizes (cm) were recommended:

| | | | |
|---|---|---|---|
| Circumference diameter | 850 | 1050 | 1250 |
| Height | 220 | 250 | 250 |
| Ring diameter | 60 | 65 | 65 |

## 3. Door

A door would increase the price of a net but might make it easier to use. However, a net with a door might be less effective if it is not properly treated or perfectly adjusted. A minimum 60cm overlap was recommended to prevent mosquito entry. For stockpiling purposes, doors

are not included in UNICEF or UNHCR orders. There is currently little information on doors and no demand through WHO for nets with a door.

### 4. Border

A sheeting border is sometimes requested to improve lifespan of nets. However, the border requires extra manufacturing time, extra cost, and extra insecticide absorbed. A border is not included in the standard specifications, though it might be optional, pending information is provided before purchasing. The lower end of nets is usually stitched, hemmed, or is given a "finished" edge.

### 5. Label

Two kinds of labelling were proposed: a permanent label attached to the net and a pictorial leaflet to go on or inside the plastic bag, relating to insecticide treatment and care of nets.

The tag on nets should include:

- The type of material (e.g. polyester).
- Water retention in millilitres for the whole net (absorbency is important for insecticide treatment). Although a water retention indication would not be relevant for long-lasting pre-treated nets. it should preferably be maintained until it is established that such nets do not really need further retreatment.
- Dimensions in cm (height, width and length for rectangular nets, net diameter and height for conical nets); surface area in $m^2$ might also be important for calculating insecticide quantities for dipping.
- Pictograms or simple instructions should also be included in order to avoid frequent washing, high temperature or dry cleaning (solvents), bleaching and exposure to sun. However, pictograms are standardised and those already existing (ISO 3758) would indicate: wash gently (by hand or machine) at no more than 40° C, no bleaching, no use of drying machine, no ironing and no dry cleaning. According to ISO standards, the five pictograms have to be used all together, not individually and should be accompanied by the corresponding explanatory text.


**Gentle wash** **No bleach** **No ironing** **No dry cleaning** **No tumble**

The pictorial instructions on the sachets or inside (glossy or reinforced paper leaflet) would provide suggestions how to use the nets properly. The people depicted should be dressed in local style so that buyers can relate to them. Suitable methods for hanging or supporting nets should be shown, and these should also reflect local habits. Social marketing organisations have done considerable research on this, and their leaflets may be adapted. For nets, other than long-lasting nets, it should be specified that they must be treated and/or retreated after a specified number of months. Labelling could be designed and written in local languages according to specific requirements of registration authorities from the concerned countries.

The pictorial leaflet should include:

- The size in cm and surface area in $m^2$;

- Absorption in ml for the whole net;
- Washing instructions (e.g. should use soap and not use chlorine or bleach. See above for pictograms);
- Instructions not to leave the net in the sun;
- A warning that washing removes the insecticide;
- Whether or not the net is treated with insecticide. If treated, it should be indicated: the insecticide and formulation used, the manufacturer, the dose of active ingredient per $m^2$, date of treatment, the expectation of active life after opening the bag and starting to use the net.

Waiting for further development and eventual massive use of long-lasting nets, the forum recommended that in most situations it is better to treat or demonstrate treatment while selling the net, since it will not otherwise be apparent that the net has been treated. Treatment demonstration usually improves sales and retreatment rates the following year. For non-treated nets, single dose tablets or sachets should preferably be included with the net bag together with simple pictorial instructions for treatment if home retreatment has been adopted and promoted in the concerned area.

## *6. Net attachment*

Rectangular nets should be equipped with non-rusting metal rings (e.g. aluminium), six for 130 cm width nets, eight for 190 cm) or the same number of reinforced fabric loops. Conical nets should be equipped with a non-rusting ring.

*Annex 1*

# List of participants

Meeting on Specifications for Netting Materials
WHO/HQ, Geneva, 8-9 June 2000, Room M.305

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*Annex 2.*

# Minimum specifications for polyester netting, design of nets and labelling for institutional buyers

| Polyester Netting | Threshold value or range | ISO Standard |
|---|---|---|
| Fabrication | Warp knitted | (ISO 8388) |
| Fibre analysis | 100% polyester | (ISO 1833), optional |
| Filaments | multi-filament, 36 filaments or higher | |
| Mesh size | Minimum 156 hole/inch$^2$ (25 holes/cm$^2$) | |
| Denier | 75 or 100 | (ISO 2060, DUPRO), optional |
| Weight | 75 denier: 30 g/m$^2$<br>100 denier: 40 g/m$^2$ | (ISO 3801) |
| Dimensional stability | Shrinkage less than 5% | (ISO 5077) |
| Bursting strength | 75 denier: minimum 220 Kpa<br>100 denier: minimum 405 Kpa | (ISO 2960) |
| Fire safety* | 16 | (CFR 1610) |

* ISO 6941: 1984 Textile fabrics—burning behaviour—measurement of flame spread properties of vertically orientated specimens.

### *About the net itself (unless other specified)*

- Minimum size for rectangular nets: 180cm long, 130 cm width and 150 cm high.
- Without door.
- With finished edges.
- Aluminium rings for hanging rectangular nets (six for 130 cm width, eight for 190 cm) or same number of reinforced netting loops.
- Non-rusting ring for conical nets.

### *Labelling on the net*

| | |
|---|---|
| Specific data: | Size in cm (L,l,H) |
| | Water absorption in ml per net |
| General pictograms: | Washing 40° C, No bleaching, No drying machine, No ironing (ISO 3758), No dry cleaning. Below pictograms: "Gentle wash. No bleach. No ironing. No dry cleaning. No tumble." |

### *Labelling on or within packaging for ready-treated nets*

- Name of insecticide manufacturer
- Name of insecticide used
- Name of insecticide formulation
- Dose in mg of active ingredient per $m^2$;
- Date of treatment;
- Expected effective life of treatment after opening of the bag and the need for regular retreatment (unless long-lasting treated net).
- Five ISO 3758 pictograms with following instructions “Gentle wash. No bleach. No ironing. No dry cleaning. No tumble”.

### *Labelling on or within packaging for non-treated nets*

- Size of the in cm and surface area net in $m^2$.
- Water absorption in ml.
- Information on insecticide and treatment instructions if single dose insecticide and treatment kit is provided with the net (optional), expected effective life of the treatment and the need for regular retreatment.
- Five ISO 3758 pictograms with following instructions “Gentle wash. No bleach. No ironing. No dry cleaning. No tumble.”

Roll Back Malaria is a global partnership founded by the governments of malaria-afflicted countries, the World Health Organization, the UN Development Programme, the UN Children's Fund and the World Bank. Its objective is to halve the burden of malaria for the world's people by the year 2010 by saving lives, reducing poverty, boosting school attendance and making life better for millions of people living in poor countries, especially in Africa.

If you are interested in becoming part of the Roll Back Malaria movement, receiving the RBM newsletter and becoming part of the global success story in reducing malaria, please write to:


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