



ZeroFly®

Shelter

Long-Lasting
Insecticide-Incorporated
Plastic Sheeting
for malaria prevention in
complex emergencies



Plastic sheeting is among the first of aid articles to be distributed to refugees in emergency situations. When plastic sheeting is equipped with vector control abilities, it becomes a highly efficient health improvement tool.

The ZeroFly® Concept

One third of the world's annual malaria deaths occur amongst populations affected by conflicts in Sub-Saharan Africa. Malaria may account for between 50 and 90 percent of all outpatient consultations and over 50 percent of deaths, particularly during the acute emergency phase¹.

The acute stage of emergencies, when people are the most vulnerable, may last for several months. In these situations, when international organisations are the main provider of essential services, the focus is on lifesaving operations. Disease prevention interventions tend to be implemented at a much later stage or not at all. Resources, time and operational constraints reduce the suitability of available prevention strategies such as insecticide-treated nets and residual spraying used for malaria control. As a consequence, malaria remains largely unaddressed in complex emergencies.

To bridge the gap between the acute phase of an emergency and the time when proper infrastructure is established, the ZeroFly® shelter, a long-lasting insecticide-incorporated plastic sheeting, has been developed as a dual function tool providing both shelter and malaria prevention.

Using ZeroFly® shelter as a malaria-control tool has the following advantages:

- Emergency shelter material such as plastic sheeting is often the first thing on the ground, and malaria prevention therefore begins immediately.
- In acute emergency situations with high death rates, the priorities of the displaced families focus on the most tangible issues related to survival, such as food, water and shelter, which increase the likelihood of use and retention.
- Malaria prevention is provided with an increased speed of response and cost-effectiveness since insecticide is incorporated into a product being sent into the field.

ZeroFly® shelter is a preventive intervention developed by Vestergaard Frandsen to change the health management of the most vulnerable people on earth — the displaced.

¹WHO report. 2002. Capacity building for Roll Back Malaria in Complex Emergencies



The circumstances of a complex emergency undermine any pre-existing malaria control measures and lead to a collapse of health services. Population movements and displacement, increased vulnerability due to malnutrition and concurrent infections, poor or absent housing, poor coordination among health agencies, and environmental deterioration resulting in increased vector breeding all contribute to the increased malaria burden. As a result, people become more vulnerable to malaria attacks, severe malaria and death from malaria.
– World Health Organization

Complex Emergency Issues

- More than 200 million people live in countries in which complex emergencies affect not only refugees and internally displaced people (IDPs), but the entire population².
- There are 11 million refugees worldwide, with more than half in Asia and 20% in Africa³.
- There are an estimated 26 million IDPs around the world. About two-thirds of these IDPs are displaced within their own country⁴.
- The biggest new displacement in 2008 came in the Philippines, where 600,000 people fled fighting between the government and armed groups in the south. There were also large-scale displacements of 200,000 people or more in nine other countries: Sudan, Kenya, Democratic Republic of the Congo, Iraq, Pakistan, Somalia, Colombia, Sri Lanka and India⁴.
- More than 80% of current complex emergencies are in malaria-endemic areas⁵.
- A survey in eastern DRC showed that, during a period when violent deaths increased 5.5-fold, malaria-specific mortality increased 3.5-fold, including adult deaths⁵.
- In 2007, malaria caused 21% of all reported refugee deaths and 26% of <5 yrs refugee deaths. Malaria caused 23% of total morbidity and 25% of under five morbidity. 13% of all cases reported by WHO linked to forced migration/civil war⁶.
- A massive malaria epidemic occurred in Burundi between October, 2000 and March, 2001, affecting seven of 17 provinces; there were over 2.8 million cases in a country with a population of 7 million. A combination of population movement, long-term breakdown in control efforts since the war started in 1993, and high levels of *Plasmodium falciparum* resistance to chloroquine were suggested to be the causes⁷.
- Plastic sheeting is one of the most widely distributed non-food relief items used in humanitarian operations. For families displaced by conflicts or whose homes have been damaged by disasters, plastic sheeting can be a useful temporary building material for repairs or emergency shelter structures⁸.

² Connolly, M.A. *et al.* 2004. Communicable diseases in complex emergencies: impact and challenges. *Lancet Vol* 364: 1974–83

³ UNHCR. 2009. <http://www.unhcr.org/pages/49c3646c1d.html>

⁴ UNHCR. 2008. <http://www.unhcr.org/pages/49c3646c23.html>

⁵ WHO. 2005. Malaria Control in Complex Emergencies: An inter-agency field handbook

⁶ http://www.who.int/global_health_histories/seminars/presentation36.pdf

⁷ WHO. 2002. Prevention and control of malaria epidemics. 3rd meeting of the Technical Support Network. WHO/CDS/RBM/2002.40

⁸ Shelter for Life, International, Inc – A guide to the specification and use of plastic sheeting in humanitarian relief



ZeroFly[®] Shelter also protects users against weather and provides privacy.

Product Overview

ZeroFly® Shelter

- ➔ Is a long-lasting insecticide-incorporated plastic sheeting, which remains effective for up to one year
- ➔ Is a single solution to the dual needs for shelter and protection against vector-borne disease in complex emergencies
- ➔ Insecticide continuously migrates to the surface, which makes it highly effective against disease vectors, such as mosquitoes carrying the malaria parasite
- ➔ Can be used to construct temporary shelter, latrines, hospitals and schools
- ➔ Is cost-effective as a malaria prevention tool, as insecticide is incorporated directly into a product that is often the first intervention in complex emergencies
- ➔ Saves delivery time for malaria control as shelter is often the first thing on ground, thus reducing the dependency on specialised control teams
- ➔ Is highly valued by refugees, as plastic sheeting is essential for shelter and survival
- ➔ When used on a large scale in a town or refugee camp, the product creates a 'mass effect' that brings down the density of pathogen-transmitting vectors in that area
- ➔ Has a black centre weave, which ensures opacity and thus privacy to the user

Working Principle

ZeroFly® Shelter is constructed of a woven centre fabric, with lamination on both sides. Insecticide is incorporated in the woven centre fabric.

The insecticide will over time migrate through the laminates to the surface of the plastic sheeting, giving the product vector control abilities. In the lamination there are several UV protectors, some of which protect the insecticide and others that protect the plastic material.

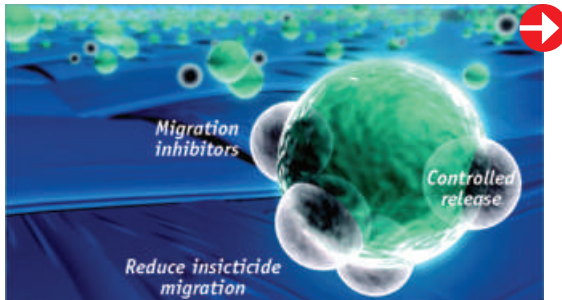
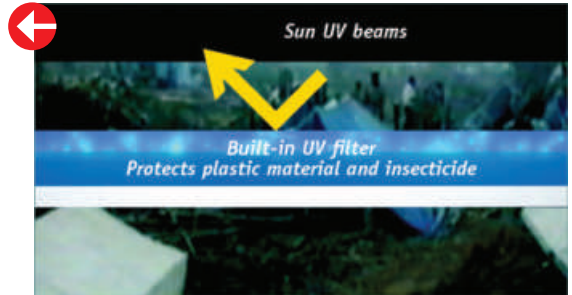
In the lamination there are chemicals that control the migration of the insecticide, leading to a slow release and securing an adequate concentration of insecticide on the surface at all times.

The UV protectors that protect the insecticide have the ability to migrate with the insecticide to prevent degradation throughout the migration process.



UV Protection System

- UV protection system with dual action
- Protects the plastic material
- Protects the insecticide

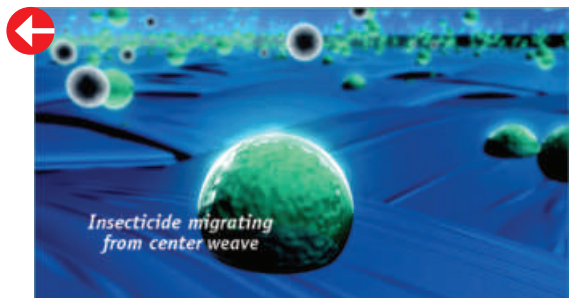


Insecticide with Migration Inhibitors

- The natural migration speed of insecticide is too fast
- Migration inhibitors reduce the speed of migration
- Result is "controlled release"

Insecticide Migrating from Centre Weave

- Insecticide is stored in the centre weave
- Insecticide migrates to the surface when needed
- Is well protected against sunlight
- Prolongs active period of the shelter for up to 9–12 months





ZeroFly® Shelter was distributed to the internally displaced population of Aceh after the region was hit by a devastating tsunami in December 2004.

Technical Specifications

Item	Requirement	Test Standard
Basic specification		
Construction	Centre fabric	HDPE flat yarns, woven Mesh size: target at 14 x 14 yarns per inch Colour: Black
	Coating/ lamination	LDPE film Colour: Blue (on both sides)
Reinforced borders and/ or eyelets		
Eyelets	Material	Aluminium or non-rusting steel
	Placement	One in each corner and one per metre $\pm 5\%$ on all four sides. The eyelets are mounted in the fold
Reinforcement border	Material	3 mm diameter cord
Material specification		
Size	4 x 5 metres $\pm 5\%$	
Insecticide (Deltamethrin)	2.5 g/kg $\pm 25\%$	CIPAC 333, modified
Bio-efficacy	Min. 80% Functional Mortality (Fm24) or min. 95% Knockdown (KD60), tested with susceptible <i>Anopheles gambiae</i> and <i>Aedes aegypti</i>	WHO Guideline 2005.11
Weight	200 g/m ² $\pm 5\%$	ASTM D 3776, option C or ISO 3801
Tensile strength	Min. 600 N	ISO 1421, Grab test
Tearing strength	Min. 100 N	ISO 13937-3 (wing shaped)
UV resistance	Maximum 5% loss of original tensile strength after a minimum of 1500 hours radiated under ASTM G53/94 (UVB313 nm peak)	ASTM G53/94 ISO 1421
Temperature resistance	ZeroFly® performs well in the range of -20°C to 80°C based on the basic material of polyethylene. Test is not required.	
Fire resistance	Flashpoint min. 200°C	CPAI 84-1995 section 6
	Optional test: shall not ignite	ISO 6940, exposed to a test flame for 10s
Printing/ label		
Logo	On request	
Fabrication	Batch code, month, year of production	
Markings	Marking every tarp	
Packing		
Sheets	Each sheet is packed in a plastic bag. Ten (10) sheets are packed in a bale. Each bale is wrapped in a woven bag. Bale is compressed with straps on each direction.	
Shipping volume	Min. 2800 pcs in a 20' container	
Storage		
Storage condition	Store in dark, dry and cool condition	
Shelf life	Minimum 2 years	

Evidence of the Impact of Insecticide-Treated Plastic Sheeting/ Tarpaulins and Tents

Insecticide-treated plastic tarpaulins for control of malaria vectors in refugee camps

Reference Graham K. *et al.* 2002. *Medical and Veterinary Entomology*

Objective To compare the insecticidal efficacy of plastic tarpaulin sprayed with deltamethrin on its inner surface (target dose 30mg/m²), tarpaulin impregnated with deltamethrin (initially > 30mg/m²) during manufacture, and a tent made from the factory impregnated tarpaulin material.

Key Findings Laboratory and field experiments confirm a level of efficacy near 100% for ZeroFly® plastic sheeting. In refugee camps where coverage is high, the prospect for malaria control would remain high due to the mass killing effect of vector mosquitoes.

Conclusion Insecticide-treated plastic sheeting has potential as a wider public health tool against various vector-borne diseases in refugee camps.

The indoor use of plastic sheeting pre-impregnated with insecticide for control of malaria vectors

Reference Diabate A. *et al.* 2006. *Tropical Medicine and International Health*

Objective To evaluate the efficacy of pyrethroid-treated plastic sheeting (ITPS) applied as a lining to the ceiling or walls of rooms against pyrethroid-susceptible and pyrethroid-resistant *Anopheles gambiae*.

Key Findings ITPS had a major effect on the mortality of mosquitoes, the proportion killed being dependent upon the surface area covered. Homozygotes for *kdr* resistance showed lower rates of mortality than did heterozygotes or homozygotes for susceptibility. Deterred entry of mosquitoes and inhibition of blood feeding were also correlated with surface area covered. The mode of action and efficacy of ITPS seems to bear closer resemblance to that induced by indoor residual spraying (IRS) than to that induced by insecticide-treated nets.

Conclusion ITPS might be conceived as being equivalent to long-lasting or permanent IRS but without some of the operational constraints normally associated with spraying. High coverage of ITPS could potentially have a mass population effect on mosquitoes and give rise to long-term community protection against malaria.

Tents pre-treated with insecticide for malaria control in refugee camps: an entomological evaluation

Reference Graham K. *et al.* 2004. *Malaria Journal*

Objective To evaluate the entomological efficacy of tents made of untreated canvas with deltamethrin-treated polyethylene threads interwoven through the canvas during manufacture (from which ZeroFly® is constructed).

Key Findings The insecticide-treated tents were effective both in killing mosquitoes and reducing blood-feeding. Mean 24 hour mortality was 25.7% on untreated tents and 50.8% on treated tents in wild anophelines and 5.2% on untreated tents and 80.9% on treated tents in insectary-reared *Anopheles stephensi*. Blood-feeding of wild anophelines was reduced from 46% in the presence of an untreated tent to 9.2% in the presence of treated tents and from 51.1% to 22.2% for insectary-reared *An. stephensi*. In contact bioassays on tents weathered for three months there was 91.3% mortality after 10-minute exposure and a 24 h holding period and 83.0% mortality after 3-minute exposure and a 24 h holding period.

Conclusion The use of pyrethroid-treated tents is already established as a malaria control intervention. A technology that enables tents to be pre-treated with insecticide during manufacture and be shown to retain insecticidal efficacy for up to one year would improve the feasibility of malaria control during the acute stage of an emergency.



Field Evaluation of ZeroFly® Long-lasting Insecticide-treated Plastic Sheetting

Sierra Leone Camp-Scale Trial

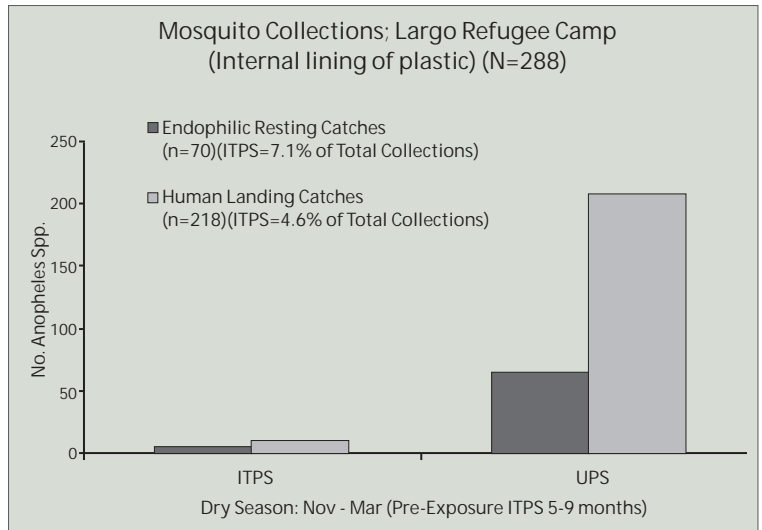
- 2 locations
- Multi-year
- Vector control
- Malaria parasitaemia reduction
- Health impact



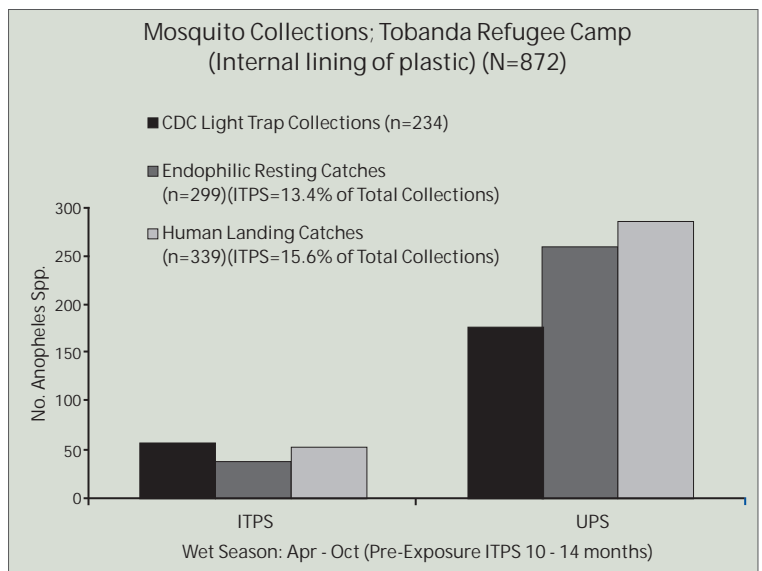
A study conducted in Sierra Leone where two large communities of displaced persons were provided with ZeroFly® Shelter demonstrated the performance value and high user acceptance of this technology for malaria vector control.

The use of ZeroFly® in such complex emergency settings will allow for rapid coverage of the at-risk population while reducing logistics involved with camp spray programs.

During the dry season the number of mosquitoes obtaining a blood meal was considerably less in sections of the camp where displaced persons lived under ZeroFly® Shelter versus untreated plastic sheeting.



The positive effect of ZeroFly® Shelter in reducing mosquito density, host locating numbers, and successful blood feeding continued even during the wet season 10-14 months after the shelters were installed in the refugee camp.





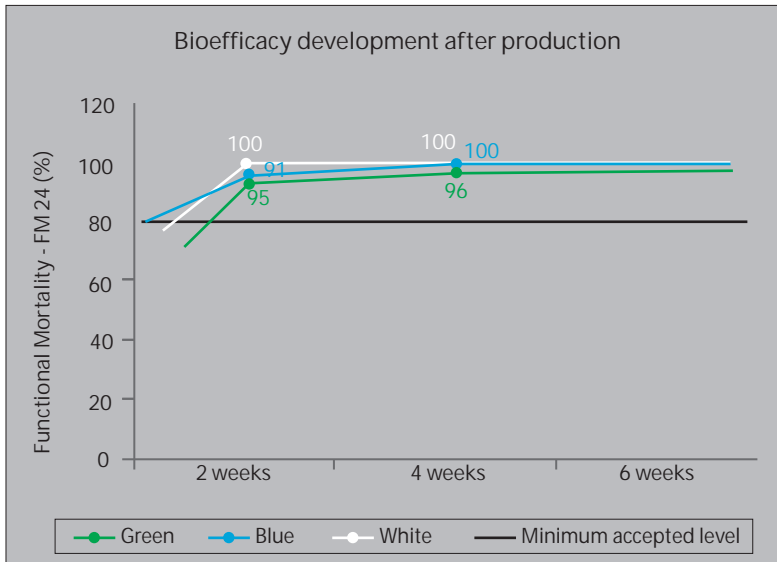
Summary of Laboratory Trials

Ten samples of ZeroFly® plastic sheeting were randomly taken from production – five samples each in green, white and blue colours. The samples were evaluated on the following parameters:

- Dimension and visual check
- Physical properties (tensile and tearing strength)
- Chemical properties (retention of deltamethrin)
- Bioefficacy
- Fire resistance

ZeroFly® plastic sheeting meets the technical specifications set for all the above.

The bioefficacy of ZeroFly® was evaluated against *Aedes aegypti* using the WHO cone test. The below figure shows the increasing functional mortality (FM) verses time, indicating deltamethrin migration in the lamination. The bioefficacy of the product reaches almost 100% shortly after production. ZeroFly® plastic sheeting meets the requirements of the WHO cone test, with 30 minutes contact time.





Quality Control

Vestergaard Frandsen maintains quality control standards necessary to meet WHOPES specifications. We have our own internal laboratories complying with WHO protocol. This ensures real time monitoring of quality.

Quality Control samples of ZeroFly® plastic sheeting are taken randomly from production, coded uniquely and allotted a reference number, which is quoted in every purchase order.

The QC sample is sent to QC laboratories for testing, the methodology of which is described below:

Master Batch (MB): Before the start of production of each lot of ZeroFly®, a five gram sample is extracted from both the ZeroFly® Low Density Polyethylene (LDPE) and the ZeroFly® High Density Polyethylene (HDPE) lots.

Central Weave (CW): Just after weaving, three samples of approximately 0.25 m² (50cm x 50cm) are taken each time after completion of approximately 10,000 square metres of fabric. The first sample is at least 100 metres from the beginning of the roll and the other two at random thereafter. All the samples must fall within two metre range on the roll.

Lamination/ finished product: After lamination, a full width sample of approximately two metres length is taken at the position where the CW samples were taken. This piece should contain both samples of the finished product and the lamination samples at the places where the CW samples were taken.

Coding/ labelling: Coding/ labelling of samples is done as per SOPS.01.

Dispatch of samples: Immediately after extracting the sample after lamination, all corresponding samples are packed independently and sent to the laboratory for analysis.

Handling of samples at the laboratory: Subsequently, the laboratory assigns parallel codes to the lamination and the finished product samples according to SOPS.01.

Reporting: Results of the chemical analysis from the laboratory are sent to Vestergaard Frandsen's production database and if deviations from the specifications sheet occur, then the results are sent to the production manager.

Storage of samples: Reference samples are stored for a period of five years with full history at room temperature, for future reference.

Chemical analysis: Samples sent for chemical analysis are used to determine the pass/ fail status of the production. The methods analyse the total concentration of deltamethrin on the ZeroFly® tarpaulin. The method is described in the SOP.C.02.1.

Certificate of Quality

Each shipment of ZeroFly® plastic sheeting is accompanied with a Certificate of Quality (COQ).

COQ summarises Quality Control testing data, including physical properties, chemical properties, dimension check, visual check, marking and packing for every batch or shipment.

Application, safe handling, transportation and use

Advisory Note (October 2004)

Potential Applications:

ZeroFly® is a plastic sheeting designed as a dual purpose tool for shelter construction and insect-borne disease control. It incorporates the slow release of Deltamethrin, which migrates gradually to both surfaces of the exposed plastic sheeting.

Deltamethrin is a WHO-recommended insecticide that is commonly used for the impregnation of mosquito nets and for indoor residual spraying. It controls mosquitoes, house flies and other insects by contact and ingestion.

ZeroFly®, when used as the inner and/ or outer wall of a shelter, may help to control mosquitoes that bite and rest indoors. This works in a similar way to indoor residual spraying. When used as the outer surface of a shelter, or latrine, this material will help to control insects which prefer to rest on the outside of shelters, such as house flies.

Maximum insect control will be achieved when the total inside and outer surface area of the shelter, or latrine, is made of this material. Used in this way significant protection from malaria may be achieved for the occupants who sleep under the shelter. Where ZeroFly® is used only for roofing material of shelters (and not walls) this may be beneficial for insect control but is unlikely to provide adequate malaria control alone and should be used in conjunction.

Safe Handling and Transportation:

Deltamethrin is recommended by WHO for use in malaria control materials. It has low human toxicity risk when combined with materials such as ZeroFly®. Independent safety tests recently conducted on ZeroFly® show that it is both safe to use as shelter material and has no significant accumulative effect in humans, rain water, or soil when used in these applications.

Skin contact with deltamethrin can cause skin irritation. When transporting, storing, or using this material for shelter/ latrine construction:

- Avoid children handling the materials where possible.
- Ensure all users wear PVC, or other, protective gloves for handling the material.
- Wear full clothing to minimise any skin contact.
- Ensure that soap and water are always available for all people handling this material. Advise shelter occupants to minimise direct contact with the material once construction is completed.
- Use of ZeroFly® for food storage or as a surface for food preparation by camp residents is not appropriate and should be actively discouraged.

First Aid

Symptoms from exposure to deltamethrin will generally be short lasting and will normally wear off in a few hours.

- In the event of breathing difficulty place the person in fresh air. If symptoms persist seek medical attention.
- If skin irritation occurs, remove any contaminated clothes and wash skin (and clothes) thoroughly with soap.
- If irritation of the eyes occurs then flush the eyes with large amounts of clean water. Seek medical attention if irritation persists.

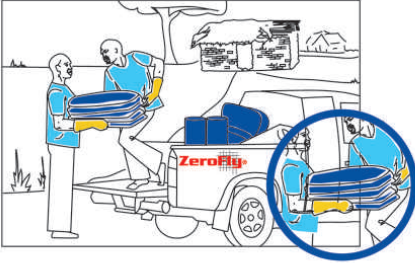


This MENTOR Initiative advisory note does not imply, in any way, endorsement of this, or other, commercial products.

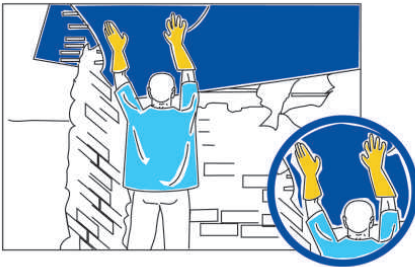
Please refer to www.rbm.who.int for further information.

Handling Instructions

➔ Dos



Wear protective gloves while handling the plastic sheeting.

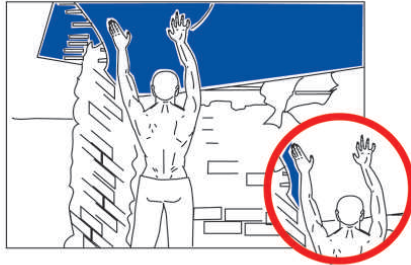


Wear full clothing to minimise any skin contact.

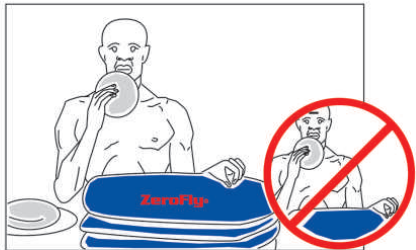


Wash hands and other exposed body parts with soap and clean water.

➔ Don'ts



Minimise direct contact with the plastic sheeting after it has been installed.



The Plastic Sheetting should not come into contact with food as contamination can occur.

References of Usage

More than 200,000 ZeroFly® Shelters have been sent to protect IDPs in Sudan, Sierra Leone, Madagascar, Liberia, DRC, Gambia, Haiti, Sri Lanka, India and Indonesia. To mention a few:

Indonesia (2005/2006)

In Aceh (tsunami), over 20,000 ZeroFly® plastic sheetings were used to provide emergency shelter for over 100,000 IDPs; and in the Java earthquake, over 17,000 ZeroFly® plastic sheetings were used to re-construct houses, schools and clinics.

India (2005)

70,000 victims of the Kashmir earthquake were sheltered and protected with ZeroFly® Shelter.

Sierra Leone (2003-2005/6)

14,000 Liberian refugees were housed in two camps in Sierra Leone by The Mentor Initiative.

Liberia (2003-2005)

13,000 Liberian IDPs were housed in two camps in Liberia by The Mentor Initiative.

Findings from a survey conducted by The Mentor Initiative in Indonesia:

- ITPS proved feasible to use on varied Indonesian shelter/house designs
- 82% people said that ITPS had a significant impact on insects of all types
- 94% reported no incidence of malaria or dengue whilst living under ITPS
- 73% said that they would be happy to live under ITPS again



Logistics and Customer Support



Delivery

Vestergaard Frandsen works with a multitude of local partners to provide the exceptional service of delivering products to in-country destinations rather than simply shipping them to the container port, as is the case with most other suppliers. We have developed a distribution network across the African continent, establishing delivery channels for deeper penetration inland and ensuring a seamless delivery to the end destination.

Warehousing

Vestergaard Frandsen has warehouse facilities in the remotest parts of the world, allowing the company to help programme implementers distribute ZeroFly® Shelter affordably and efficiently.

Global Customer Support

With 11 regional offices across Africa, Asia, Europe and the Americas, Vestergaard Frandsen provides an exceptional local and international customer service. Being close to the market is an unequivocal benefit for our customers and partners, allowing rapid and proactive service and market intelligence.

This unique profile makes Vestergaard Frandsen the optimal partner for disease control needs.

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ZeroFly®





DISEASE CONTROL TEXTILES

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