# Winterised tent evaluation
# IFRC Jan 2007:

**Locations:** NWFP Pakistan

 

**Mission dates:** 05.01.07 – 15.01.07

**Report by:**

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## Contents

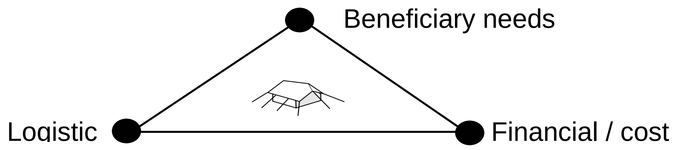
# 1 Abstract:

This evaluation of family tents was conducted in January 2007, in NWFP, Pakistan, by Linda Stops (IFRC) and Joseph Ashmore (Consultant) over a period of ten days. Sites in Khagan and Allai valleys were visited as well as Balacot, Thakot Union Council and Kastara and Jaba camps. A full mission itinerary is in annex A, and a map is in annex B. The evaluation had the objective of learning lessons for IFRC from Pakistan for future tent specification and development. It does not seek to promote tents as a universal emergency shelter solution, but is intended to inform improvements to their quality when they are used.

This evaluation did not include “transitional shelters”, the multitude of structures that use timber or corrugated iron sheets.


# 2 Executive summary

The ideal tent is a careful balance of covered living space and quality needs against logistic and financial constraints. The ideal tent would pack into a coat pocket, yet provide a sizeable secure windproof cover and be very low in cost. Such a tent does not exist, but by careful design and detailing a compromise of the various constraints can be reached.




*The ideal tent must balance a combination of factors. It lies somewhere inside a triangle of important considerations in any disaster: Beneficiary needs, logistical and financial limits*

This evaluation focused on tent performance in cold climates and re-established that:

- A tent alone is not the only shelter solution for cold climates. Tents should be distributed with other non-food items (NFIs). A tent alone cannot provide protection from the cold.
- Tent distributions should be accompanied by training aimed at: helping people to understand the features of the tents, improving fire safety and drainage around tents and reducing vulnerability of tents to collapse.

With regard to tents evaluated:

- A universal hot and cold climate tent does not currently exist in the opinion of the beneficiaries or the authors of this report. Different structures may be required for both climates.
- The “Chinese frame tent” (section 4.2) was the single most popular of tents distributed in Pakistan. This was followed by the “Turkish tunnel tent” (section 4.3). The weight of both of these tents is in excess of 110 Kg. Lower quality copies of the Chinese frame tents were also popular.
- The “Extended Ridge tent” was the most popular of the canvas tents distributed in Pakistan. However, there remains significant room for improvement over those observed in terms of design detailing and fabrics used.

## 2.1 Key Recommendations to IFRC:

- Focus on the extended ridge tent to use as the cold climate standard tent. This is in the absence of a proven alternative winterised tent of comparable weight.
- Develop frame tents for re-use as transitional structures.
- Investigate alternative synthetic fabrics to poly-cotton. Poly-cotton canvas remains a less than ideal fabric with limited storage and field lifetime due to mildew and decay. Current specifications for polycotton do not include tests for UV exposure.
- Until improved fabrics are available, add a plastic sheeting cover with welded seams to cold climate tents.
- Improve usage instructions a) for beneficiaries and b) for field workers.
- Ensure tents are procured to precise specifications to help with quality control.

# 3 Introduction

## 3.1 Background

### 3.1.1 Tents n context

Although the preferred shelter responses include more local structures and materials, there are many cases where tents are the most effective option for getting people quickly under cover and protecting them from the elements. They can also help to provide basic security and help people to maintain privacy and dignity.

### 3.1.2 Pakistan context

The Earthquake in Pakistan 2005 struck a mountainous area of Kashmir and North Western Frontier Province (NWFP). It struck in October an as a result, many families found themselves forced to live in tents over the winter. Although the winter was not as severe as many expected, many people found themselves living in damp tents for months in freezing conditions with occasional snow falls, wind and cold rain.

During the fifteen months since the earthquake, the majority of families have built themselves more durable structures, ranging from traditional Katcha houses through to structures with more modern Corrugated Iron (CGI) roofs. Many of these people are still using tents for additional storage. For the minority of families still living in tents, most, (apart from those most recently displaced by landslides, snow or flooding), had built additional structures such as kitchens. Although many of the families were not solely dependent on tents for all of their cover, the evaluation was able to assess how well the tents had survived and how they had been adapted to meet needs. It also attempted to analyse retrospectively, details of the tent failures from the winter of 2005-2006.

The weather in the earthquake affected area varies considerably, with temperatures regularly falling below freezing in winter and rising above $40^0$C in summer. In the higher altitudes, (upper reaches of Allai and Khagan valleys) there is snow cover for most of the winter, although coverage varies with orientation of hillsides as well as their altitude. In the higher altitudes, where some people were living in tents in winter 2005-2006, there are reports of over 50cm of snow falling in a single night on one or two nights of the year. At the lower altitudes (Balakot, Battagram, Thakot Union Council), snowfalls are less common, but still occur during most winters. Heavy snow falls caused some secondary displacement from the higher altitudes after the earthquake in 2005-2006. The population of Kastara camp claims that they have been displaced from Khagan valley by snow falls this winter (2006-2007)

Despite the cold weather, families were not allowed to use stoves or fires in the tents. This was due to fire risk. As a result, the use of chimneys could not be evaluated, and living conditions might vary from other cold climate contexts.

## 3.2 Methodology

The key information gathering was conducted through:

- Informal interviews with tent occupants, field staff from IFRC, Pakistani Red Crescent Society, other international organisations, the Pakistani military and tent camp managers.
- Correspondence with overseas workers who have completed their missions in the earthquake zone.
- Observation and photography of tents, details, and surroundings.
- Comparison of written specifications on tent design.

## 3.3 Further reading and references

The following references were found to be useful to the assessment team:

- Specifications of tents from suppliers, and relief catalogue entries from relief organizations.
- Tents, A guide to the use and logistics of family tents in humanitarian relief, UN/OCHA 2004, (available from www.shelterproject.org).
- Sphere, The Sphere Project, The Humanitarian Charter and Minimum Standards in Disaster Response, 2004 (www.sphereproject.org).

### 3.4 Published evaluations and technical documents

- Technical comparison of tent specifications, Shelterproject 2003
- Overview of shelter in 6 refugee camps in Herat Province, Afghanistan, March 2002, www.shelterproject.org
- Comparison of plastic sheeting specifications of the major organisations, December 2006, www.plastic-sheeting.org

## 4 Comparison of tents used in Pakistan

### 4.1 Overview

The majority of the informal interviews, interviewees were asked to rank the various tents available. The following results were almost unanimously obtained:

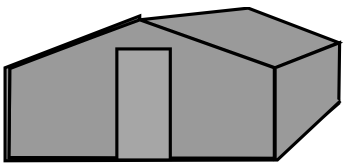
1. Chinese frame tents (section 4.2).
2. Steel framed tunnel tents (section 4.3).
3. Extended ridge tents (section 4.6).
4. Ridge tents (various 4.4).

The centre pole tents (4.5) were not as common as the other types of tent and hence are not included in this list. However, they were generally viewed less favourably and were found to be in a poorer condition than the extended ridge tents (section 4.6)

These preferences were due to both the shapes of the structures being closer to houses that people traditionally live in, and the quality and durability of the poles and covering fabric. The stated water resistance of the covering of the steel framed tunnel tents was ten or more times that of the ridge tents. Additionally the Chinese and Turkish frame tents both included in excess of 60KG of steel tubing.

Covered space in the various tents varied from $12m^2$ to $27m^2$. However, usable covered space should not be considered as solely floor area, but also should take into account space lost by sagging ceilings.

### 4.2 Rectangular frame tents (Chinese tents)



*Rectangular frame tent from china – Allai Valley.*

**Description:**

Frame tents with heavy duty woven polyester covering and quilted synthetic lining. Rectangular in plan, with partial trusses for roof.

**Weight:**

Total 114kg. Fabric 62kg, poles 52kg. The packing volume is unconfirmed but is significantly larger than for a poly-cotton ridge tents

**Comments:**

These were undoubtedly the most popularly received tents in Pakistan. The cheaper copies, with lower quality frames, covering materials and no lining were still more durable and preferred to the poly-cotton ridge tents. As with all other tents in Pakistan, these tents suffered under large snow loads, failing on the trusses. The addition of plastic sheeting on the roof helped the tent to shed snow. As these tents have a rigid frame, these tents must be erected on level ground.

Rectangular shapes maximize truss size (reducing strength) but minimise the amount of fabric used.

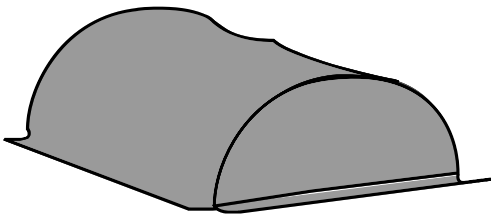
The design could be improved by:

- Adding a vestibule.
- Adding mosquito netting to the windows for use in warmer weather.
- Increasing the door overlap, and changing the hook and loop fastening (Velcro) closure system.
- Adding a groundsheet, preferably with a “bathtub” design.
- Simplifying the frame for construction, manufacture and transport.
- Improving truss design to reduce weaknesses under snow load (section 6.4).
- Replace the hook and loop fastening used to attach the wall and ceiling panels with a more traditional system such as loops and eyelets.
- Move the stove vent to the wall from above the door to improve fire safety
- Add a second door to serve as a secondary fire exit.

Additionally the following could be investigated:

- Reduction of weight (of frame and fabric).
- Reduction of insulating layers.
- Additional fixing points on the frame to support owner upgrade of their shelter.

### 4.3 Tunnel frame tents (Turkish Tents)



*Tunnel frame tents (Turkish origin) – Balakot.*

**Description:** Tubular steel framed tunnel tent. Heavy duty PVC outer and lightweight plastic sacking liner. They came in two sizes; 6mx4m and 4mx4m ground plan. The frame was held together with longitudinal and diagonal tensioning ropes. The frame was covered by three layers; – lining (made of coarsely woven plastic sacking), insulation (made of bubble wrap with a reflective coating) and weatherproof covering (440g/m2 PVC).

**Weight (4mx4m version):**

Total 110kg, fabric 40kg, bubble wrap 10kg, poles 60Kg. There are a total of 120 tent components. The packing volume is unconfirmed but is significantly larger than for a poly-cotton ridge tents.

**Comments:**

These tents were popular due to a sturdy frame and fabrics, as well as increased headroom. There were some comments from occupants that condensation had formed inside the tent but this could not be visually verified or quantified. Thermal performance in hot weather is not clear. Some occupants reported difficulties on erecting the tents.

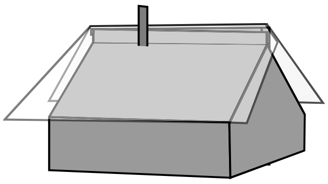
Specific design comments on the tent include:

- The doors close using zips which frequently failed.
- The tent does not come with a ground sheet.

- The tent is designed to include a minimum of seaming / sewing which simplifies fabrication. (The only seam welding is to join panels of covering fabric together, and to seam the ends, so as to fix them to the frame).
- The effect of the insulation is not entirely clear. Specifically bubble wrap may not be the most effective of insulators from a logistics perspective.
- The flat ends did not have insulation as the roof of the structure does. Although conductive heat loss is lower at the vertical ends of the tents than through the roof, the relative amounts of insulation from roof to walls is very different.
- Add windows to provide light and ventilation in summer. Currently there are no windows in these tents.

A larger (5mx6m) tunnel shaped structure was also found in some locations. This was made using standard galvanized pipe and fittings.

### 4.4 Ridge tents - various qualities distributed



*Ridge tents, Kastara camp, near Balakot.*

**Description:** Cotton or polycotton canvas tents with two or three tubular steel verticals and a ridge pole. These tents are frequently produced in Pakistan, and vary considerably in quality and make up. Key variations include; presence or otherwise of flysheet and liners, use of synthetic fly sheets. Size of tents observed varied from 3mx3m to 4mx4m covered area.

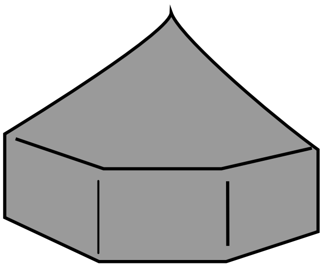
**Comments:**

Cotton canvas ridge tents are possibly one of the oldest tent designs. Multiple models of ridge tents are in use. The durability of ridge tents is largely dependent on the specification and quality of manufacture. Key quality indicators are:

- Quality and weight of the fabric. The most common failing is the flysheet not remaining adequately waterproof.
- Presence of inner liner.
- Strength and thickness of tent poles.
- Length and material quality of mud-flaps.
- Quality of stitching.

Presence of a flue opening is often used by manufacturers to indicate that the tent is winterised. However, many tents with a flue opening should not be considered as winterised, as they might leak, lack a fly sheet or suffer from poor detailing.

### 4.5 Centre Pole tent:




*Centre pole tent, Khagan valley.*

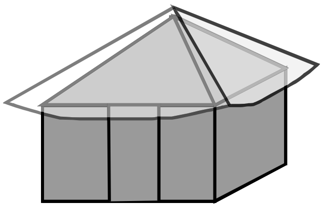
**Description:** Tent with one tall (approx. 2.5m) central pole. 1m (approx.) poles at eaves. Poly-cotton inner tent and fly sheet.

**Comments:**

These tents were less well received than extended ridge tents (4.7), but were also less common and had been in use for over one year. Some models appeared to be leaking at the flue hole due to over complex detailing. Accompanying tent distributions with education campaigns could help to explain details such as correct closure of flue holes.

- The manner in which these tents had been erected and used lead to the canvas sagging. This allowed water to puddle on the roof.
- One of the designs observed had a very low door (less than 90cm tall) which was unpopular, as people had to bend over too far to get in. It also lead to the canvas tearing more at the door.

### 4.6 Centre Pole tent with side walls: (marquee type tent)



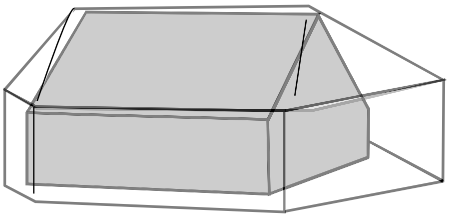

*Centre pole tent with side walls (archive mage)*

**Description:** Tent with one tall (approx. 2.5m) central pole. The walls are made from 2m canvas with bamboo poles. These tents are significantly heavier than traditional ridge tents. (In excess of 100Kg)

**Comments:**

- The manner in which these tents had been erected and used lead to the canvas sagging. This allowed water to puddle on the roof.
- These tents have significant head room, and were preferred to simple ridge tents. However, many of those found did not have a fly sheet or lining and cold air could leak in.

### 4.7 Extended Ridge Tent



*Extended ridge tent, Mansehra.*

**Description:** Ridge tent with extended ground length fly sheet and inner tent. The fly sheet is extended at the front to create a covered area. The tent has four poles of 1.1m for the eaves and two additional poles (1.2m) at the front.

**Comments:**

These were found to be the most popular of the cotton / poly-cotton canvas tents. Various qualities were identified in the field – the key variations being with:

- Quality of fabric stitching.
- Length (and quality) of mud flaps.
- Strength of poles.

### 4.8 Lightweight tents

*Light weight tent (Balakot, Winter 2005-2006)*

**Description:** Lightweight tents (40kg or less) of various designs (tunnel or dome in form). With glass fibre poles.

**Comments:**

Multiple lightweight tents were distributed and visible throughout the winter of 2005-2006, but none were observed in 2007. This appears to indicate that none have survived the year, or that these tents are not appropriate for cold climate use. It is possible that some have been stored by people for summer use. However, none of the interviewees admitted that this is the case.

### 4.9 Tents with partial fly

*Smaller frame tent, Balakot.*

**Description:** 3m x 3m frame tent canvas suspended from frame. Heavy duty synthetic fly sheet over frame.

**Comments:** These tents are relatively small, and the fly sheet does not cover the walls from all rain. However occupants were relatively positive about them, particularly as a result of the good quality fly sheet. It is also possible that the small internal volume, although not suitable for large families to live in were warmer to sleep in. Some were found that had been broken by the snows of 2005-2006. This could be because they were being used for storage and hence not being occupied and maintained at the time of the snow falls.

## 5 Use of Tents

### 5.1 Failure and snow load

*Archive photo – tent failure under snow load due to guy lines pulling out, Allai. (source Jos Miesen / IFRC)*

One of the challenges of this mission was to identify the reasons for tent failure. The failures were largely structural failure due to wind or snow load or fabric or rope failure due to sunlight exposure. The way that occupants used the tents (as opposed to the way that tents were designed to be used) may, in some cases, have damaged or reduced tent life span. An example of this would be of people adding poles to prevent the ceiling of the tent from sagging down and reducing internal space, but at the same time creating pressure points that damages the canvas.

#### 5.1.1 Tent collapse from snow loading.

Tent collapse due to snow loading was carefully investigated. Although there were few corroborated collapses in winter 2006-2007[1], collapse under snow was noted as an issue over winter 2005-2006. During the winter of 2005-2006, it appears that many tents had failed with the first snow. Significantly fewer tents had collapsed with subsequent snows. The reduced failure rates after the first snows may have been due to:

- People learning to clear snow from their tents quicker to prevent collapse.
- Subsequent snow falls being less severe than the initial snow load.
- Snow may have fallen when the occupants were awake and able to clear snow from the tents. The first snow falls occurred during the night when people were asleep.
- Many tents being used for storage of materials or otherwise being uninhabited.

In some locations, wind appeared to be a more significant cause of collapse than snow. In other locations, tents appeared to have collapsed when between 8-30cm of dry snow[2] had fallen. Rain or sleet following snowfall would be more likely to remain on the tent roof, or re-freeze. This would increase the weight of snow and increase the risk of collapse.

The most common means by which tents collapsed under snow loads appears to be (in apparent order of frequency):

- Pole failure. Failure occurred at the centre of ridge poles, both at joints and mid pole (on poorer quality poles). Frame tents failed below the trusses.
- Fixings failure. Pegs came out of ground due to poor fixing (not angled) or soft ground conditions. In these cases tents could be easily re-erected.
- Failure of canvas. In some cases, the failure of the poles lead to canvas ripping.

[1] The population in Kastara camp Balakot claimed to all have been displaced by snow fall in Khagan valley (in December 2006), but no independent evaluation of this had taken place.

[2] For a 4mx4m ridge tent, this corresponds to between 200kg and 1000kg of snow. (assuming dry snow density as approximately 100kg/$m^3$ as opposed to wet snow density up to 500kg/$m^3$ ).

*Pole failure under snow load. This pole was weakened as a result of the hole for vertical support, Allai valley.*

#### Design for snow load

Centre pole tents are the best design for dealing with snow loads as the poles are least likely to fail. However, the canvas of the remaining centre pole tents in the field was frequently observed to have sagged significantly (section 4.7). This lead to reduced internal head height. This sagging also increased the likelihood of puddles of water forming and tents failing.

### 5.1.2 Waterproofing

Care must be taken with identifying where and how tents leak. A tent might leak in many ways; through seams, down the poles, through windows or vents that do not seal properly, or through the canvas itself. Most canvas tents begin to leak in some way after a period of just a few months. The precise location where they leak is dependent on tent design, detailing, the way in which the tent has been made, as well as they way in which it has been used by its owners. This is discussed in more detail in the technical details section of this document (6.2.1).

### 5.1.3 Wind load

Failures due to winds were raised in some locations. These were not investigated in full. A poorly located and erected tent is more susceptible to failure due to wind.

## 5.2 Quality criteria according to tent occupants

Key criteria among occupants on whether a tent was good or not good were:

- Is it strong and durable?
- Is it waterproof (no rain leaks in)?
- Does it have multiple layers (e.g. fly plus inner tent plus liner)?
- Does it have a waterproof floor?
- Does it have adequate headroom?

### 5.3 Training to reduce risk of tent failure

Training at distribution sites or through mobile teams will reduce risk of tent collapse. Training should include:

- Where to locate a tent
    - Away from landslide risk, out of the wind, and out of an area of flood risk.
- Erection of tent
    - Erect with door downhill to reduce flood risk.
    - Erect the tent so that openings are away from the prevailing wind.
    - Dig drainage.
    - Options for building a raised floor or lip.
    - Do not bury tent above mud flaps.
    - Proper placement of pegs (distance from tent and angle).
    - Set up the tent with fabric taught.
    - Building of low walls around the tent to reduce draughts.
- Keep adjusting tent
    - Use the tensioning sliders on guy ropes.
    - How to use lacing.
    - Remove snow from the roof of the tent (this can often be carried out from the inside of the tent by periodically knocking the roof of the tent during snow falls).
- Fire safety
    - If stoves are used, how to best fit them to the tent, so the flue pipe does not touch the canvas.
    - Action to take in case of fire / formation of fire committees.

## 6 Technical details

### 6.1 Overview

This section summarises the specific findings regarding detailing of tents found in Pakistan. A good tent is a combination of good overall design (shape) as well as attention to design details. Precise design details need to be specified very closely to support tendering, quality inspection and resolution of differences with manufacturers.

### 6.2 Fabric

Fabrics available for the production of tents are changing. The two most popular tents in Pakistan had synthetic coverings, while the tried and tested poly-cotton canvas, although having many benefits has proven more variable in quality and durability.

*Most tents are covered with plastic tarpaulins, tent Balakot.*

Most families in Pakistan have upgraded their tents with plastic sheets as coverings. This indicates that even woven synthetic fabrics might not be ideal.

#### 6.2.1 Covering materials:

Most specifications for polycotton canvas do not have a performance specification for durability under exposure to UV, or the durability of waterproofing treatments. Many fly sheets were found to be suffering from Mildew, and many that were over six months old appeared to leak through the fabric.

***Synthetic tent covering fabrics should have improved laboratory specifications for UV stability and waterproofing durability. (refer to plastic sheeting specifications).***

**Plastic sheeting coverings**

The majority of tents had plastic sheeting tied as a cover. Generally the plastic was on top of the fly sheet rather than between the fly sheet and the inner tent. From discussions with those owning the tents, the reasons for this were:

- To prevent frost forming on canvas. When frost forms, condensation increases and the tents become damp as the frost melts.
- To prevent rain water from leaking into the tent.
- To protect canvas from sun. The value of tent canvas is greater than the value of the plastic sheeting. The plastic sheeting increases the lifetime of the tent.
- Plastic sheeting sheds snow better as it does not stick so easily to the plastic.

There appeared to be a strong association between the use of plastic sheeting as a tent covering and the growth of mildew on tent canvas. This is most likely caused by condensation forming under the plastic sheeting and moistening the tent canvas where it was in contact with the plastic sheeting.

***Unless improved materials are developed, plastic sheeting should be distributed with tents. Ideally this should be welded to fit the tents, and preferably designed to maintain an air gap to reduce condensation and the evaporation of condensation.***

### 6.2.2 Inner tent / Inner tent lining

Tents with linings were preferred to those tents that did not have linings. However, if the linings reduced the inner space by hanging down excessively, they were less popular. Tent linings were made in various colours, with yellow and white being the most common. Discussion with women indicated that white was harder to clean (cf. section 6.2.3). Ideally tent linings should be translucent to allow in light but not to compromise privacy.

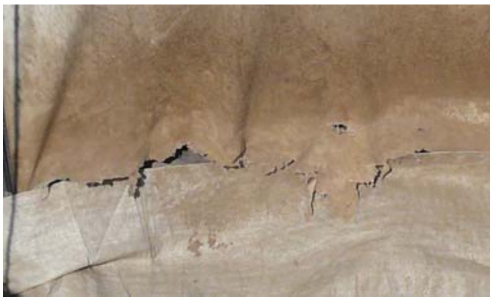
***Inner tents with linings are preferred to unlined inner tents. It is not essential for the inner tent to have insulated wadding.***

***Tent linings should be bright in colour. They should not be white.***

***Linings should not excessively hang down inside the tent.***

### 6.2.3 Mud flaps / Groundsheet

Tents with low mud flaps were seen to rot where soil had been in contact. Many mud flaps were seen to have decayed severely after exposure to sun light.



*Decayed canvas due to short mud flaps, Jaba Camp.*

***Mud flaps are essential. If mud covers the base of the canvas it will rot. Mud flaps should be at least 45cm above ground (plus a minimum of 20cm of additional fabric for burying.).***

The specification of the mud flaps for some tents is significantly lower than that for standard plastic sheeting (standard plastic sheeting must lose less than 5% strength under (ISO 1421) after 1500 hours of exposure).

***Mud flaps should have improved laboratory specifications for UV stability and waterproofing durability, using standard plastic sheeting specification as a reference.***

From discussion with women's groups, groundsheets often appear to be dirty and are hard to clean. In Pakistan, a sage green was the preferred colour.

***Groundsheets should not be white, but should be earthy colour to hide dirt.***

### 6.2.4 Divider

In Pakistan where families have access to multiple tents, men and women frequently sleep in different tents. However, where families do not have access to multiple shelters, in cultures where families sleep together or in cases of polygamous relationships with only one tent, lack of internal space segregation can lead to social and protection issues. It should be noted that if a divider is provided, it is possible that the fabric may be used for alternative uses.

***Tents should have a divider to break up internal space. Addition of a divider would cause the locations of the windows to be re-assessed.***

### 6.2.5 Webbing

Some of the tents observed used webbing to strengthen joints and external connectors. In some situations, this webbing was made from white polyester, but after months was seen to degrade due to exposure to sunlight

***All webbing used should be black or UV stabilised.***

*Detail of white webbing that has pulled through.*

Some of the webbing was stitched into the tent at fixing points, but had pulled out. On closer inspection it appeared that the webbing had unravelled at the end. To prevent this, it should be carefully seamed or heat-sealed to prevent it from pulling out of the stitching.

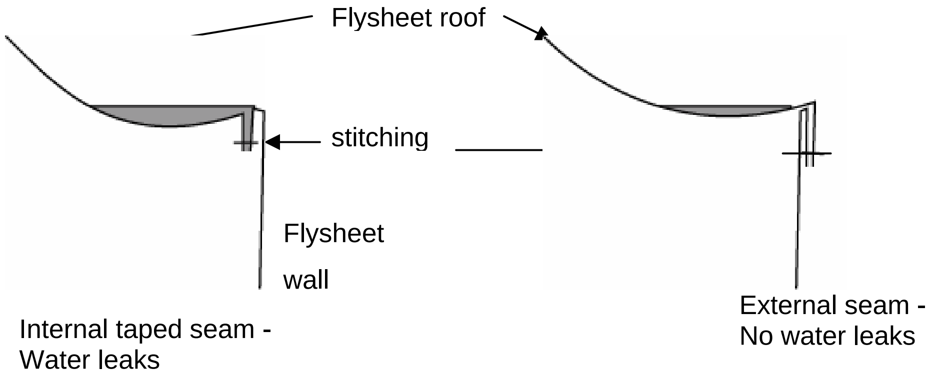
***All ends of synthetic webbings and fabrics should be heat sealed.***

### 6.2.6 Stitching

One of the design failings some of the extended ridge tents (4.7) was the seaming on the vestibule. (This fault was rectified on later tents) Stitching was such that ponds formed in the fabric on top of the vestibule leading to leaking at the seam. The design would be improved by ensuring overlapping seams with the overlap on vertical surfaces so that water ran off the tent rather than forming between folds in the fabric. (see diagram overleaf)

***Stitching should be done with seams finished so that they do not encourage water to collect.***

*Detail of seam showing were stitching was causing water to collect.*




*Diagrams showing section of sagging tent roof and side wall. Illustration of how water does not leak when seaming is external.*

There was significant variation of the quality of stitching. This was especially notable where parallel lines of stitching are required on seams. For these factories with twin needle machines created higher quality finishes.

***Factories with twin needle or cover stitch machines are preferred to ensure thee quality of the seaming.***

On some tents, seams were taped to improve waterproofing. The quality of the taping of the seams was found to be variable. On some specifications, “waterproof yarn” is specified for stitching. In practice this is difficult to validate. Specifying a waterproofing test for the seams might be easier to validate than either the effectiveness of the seaming or the taping. In the field, a rough test for waterproofing / supported water column height is to hold a transparent hose tight against the fabric and then to fill it with the required depth of water (eg 300mm).

***The total waterproofing (supported column height of water) of finished seams should be specified rather than the type of yarn.***

The location of the reinforcement patches was variable. On some tents, Reinforcement patches were missing on key areas of friction - such as where the ridge pole touched the ends of the tent.

### 6.2.7 Bathtub vs. separate ground sheet

Differing tents had different types of ground sheet; either separate or bathtub (groundsheet integral to the inner tent with edges rising off the floor). Of these types, the bathtub type was generally preferred. However there was an issue over height at which the bottom of the door should be, as it is a trip hazard and is prone to rip. Having a bathtub floor ensures that vulnerable family members have flooring, as it is less likely to be separated from a tent. They also help reduce the risk of surface water ingress. A negative aspect is that bathtub floors can be harder to clean out and wash, as dirt gets trapped in the folds of the bathtub. They must also be cut if a stove is to be used inside the tent so that the stove is not in contact with the fabric.

***Bathtub floors are preferred, although care must be taken to ensure that the lip under the door does not pose a trip hazard.***

If bathtub floors are used, it is essential that the sides of the tent are trenched to ensure that surface water is drained away and does not flood in. It was interesting to note that, unlike in other locations, no cases of raised (50 cm) mud or stone walls had been built in the tents. These are normally to be encouraged as they help to reduce drafts as well as keeping out surface water. In a few cases, the tent floor appeared to be raised slightly, and a very low (10cm) mud wall had been built.

***If allowed by the local authorities, construction of raised floors and walls and digging drainage ditches should be encouraged. It is a key component of the tent usage trainings (section 5.3).***

### 6.3 Ropes and Fixings

#### 6.3.1 Rope quality:

The major observed reasons for rope to fail were use of non - UV stabilised rope, and/or rope rubbing on tent pegs or another fixing point.

***When specifying tents, rope should be:***

***- Attached to the tent to ensure use of fixing point***

***- UV stabilised***

***- Sufficient length to assure that the tent can be securely fastened***

#### 6.3.2 Zippers and hook and loop fasteners (Velcro)

Over 50% of the observed zippers had failed. Although the qualities of the tents were variable, one or more zippers on distributed tents had failed well within the tent lifetime. In most cases they had failed within 6 months. Zippers often appeared to have failed due to large horizontal forces across the zipper.

***Zippers should not be used in tents.***

*Zippers can fail due to large horizontal forces. On left broken zipper stitched shut by tent owners, on right zip under tension*

Observed hook loop fasteners appeared to be still working even after one year. However, the observed Velcro in tents was often too narrow (25mm) and frequently did not fully meet up when openings were closed. The risk of this happening could be reduced by having wider Velcro.

When zippers failed they were often sewn shut by tent occupants. In the tents where doors entirely failed, some families were seen to hang blankets to cover the doors.

#### 6.3.3 Guy runners

Guy runners are simple metal or wooden devices with two holes in them to help with the tensioning of tent guy ropes. Wooden guy runners can be prone to splitting when under tension. Exposure to water can also cause holes in the runners to swell making it difficult to adjust the guy ropes.

*Wood guy runner showing splitting*

***Metal guy runners are preferred. When guy runners are made of wood they must be specified in detail (including timber type, grain direction, dimension, hole size, and minimum distance of the hole from the edge)***

#### 6.3.4 Pegs

Round steel pegs (rebar) with no welding are preferred to T-shape or other shapes. The pegs must be bent over $90^0$ at the tops – ideally looking like a candy cane. This reduces the risk of injury if pegs are not fully pounded into the ground, and reduces the risk of the rope falling off the ends. It should not be necessary to paint pegs if they can be stored sealed bag so that they do not rust prior to distribution.

***Round Pegs must be bent over $90^0$ at the tops***

*Varying qualities of tent pegs arriving with a new a new tent.*

It was interesting to note the various methods used by people to peg their tents. The design of most tents is such that guy ropes should be pegged 1-2m away from the tent to ensure that the walls are held high. In many locations space was limited, so people tied the guy ropes at 20cm to 1m from the ground onto wooden pegs. This helped keep the eaves higher above the ground, but also reduced the amount of space lost by guy ropes. Some families were even noted to tie the fly sheet or a plastic cover to a horizontal pole held in place with two vertical stakes. These modifications were generally positive unless the fly sheet was tied off sufficiently high that the stresses on the fabric caused tearing. Such good practice alterations could be encouraged by the education programmes that should accompany tent distributions.

*Adaptation: fixing guy ropes to a pole and beam rather than to pegs. This saves space and can help in hard ground where it may be difficult to fix multiple pegs.*

#### 6.3.5 Eyelets

Eyelets should not be used for securing guy ropes or poles as they were observed to pull through. (Stitched-in metal rigs are more secure). Eyelets should be brass or aluminium and should be of an appropriate size. They are appropriate for use with tent lacing but must be larger than the lacing cord.

***Eyelets should be not be used at points of tension that help to support the structure.***

#### 6.3.6 Connections between tent layers

Generally lacing was understood by tent users in Pakistan. The detailed design of some tents uses lacing with toggles at the end to help close the lacing. However, these toggles were not used in general.

*Detail of ridge fixings showing wire hooks which might cause canvas to fail over time.*

The inner tent of some tents is connected to the ridge either by canvas straps or wire hooks. Although no examples of failure were noted as a result, the wire hooks appeared to cause pressure points on the fly sheet above the ridge.

From experience in Indonesia, plastic toggles should be smooth. If not they are liable to cut through the cord that holds them in place.

#### 6.3.7 Flue hole

Although stoves in tents were not allowed in tents by thee authorities in Pakistan, many cold climate tents are produced with holes for flues. Tent fires were still significant issue in Pakistan and over ten people died as a result of them in the winter 2005-2006. If flue details on tents are not designed correctly, they could be more dangerous than not having them. Poorly designed or complex flue openings also caused tents to leak.

Many flue holes are designed so that they are normally covered by a flap of fabric. Poor designs are such that this flap might blow onto the stove when not in use. Safest designs of flue ensure that fabric is not in contact with them by removing surplus tent fabric and having the covering flap sewn at the bottom rather than the top of the opening.

***Attention must be made to specify detailed flue openings for fire safety and waterproofing.***

Although the policy in NWFP was for no stoves in tents, several stoves and open fires were noticed in tents. Without exception these were located near the door. This circumstantial evidence supports locating flue holes in the front portion of the tent, but not so close to doors that the stove becomes a hazard.

Some tents, such as the frame tents, had flue openings above the door, meaning that the stove would have to be placed in the doorway. Multiple flue openings could be considered depending on tent design.

***Flue openings must be located away from doors so that they do not create a fire hazard.***

### 6.4 Poles

Poles were one of the major causes of tent failure, under wind or snow load. The primary cause of failure of poles is the pole joints. The failure at jointing is due to the metal thinning at the point of the joint, as well as tent designs where the primary stresses are in the middle of the ridge where the joint is made. As an example, ridge tents with two vertical supports and a two piece ridge pole are most likely to fail in the centre where the two piece ridge poles join.

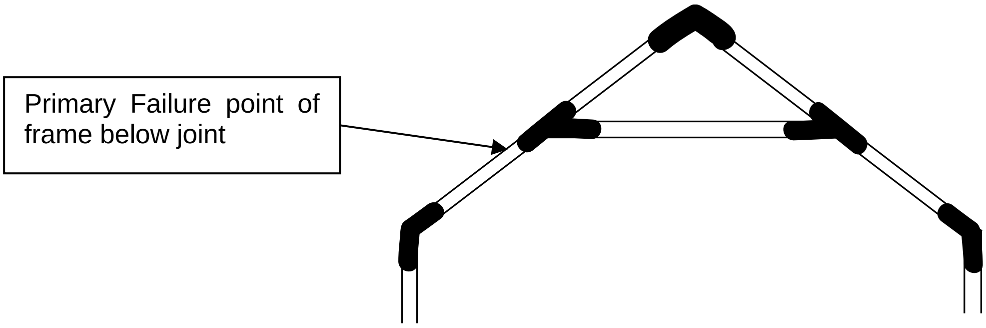
In some tent designs, there was a specific weak point where the upright poles passed through a hole in the centre of the ridge pole (cf. 5.1.1). Ridge tent designs with poles supporting the centre of the ridge rather than passing through a hole in the centre of the ridge pole were found to be stronger.

***Care needs to be taken with designing where joints between poles are so that loads are supported. Joints should be designed so as not to create structural weak points.***

*Failure of spikes on poles due to poor quality welding and not passing into pole body.*

The spikes of poorly made vertical support poles were often found to fail. Where poles did not have end caps they were found to either tear ground sheets or sink into the ground. Putting end caps on to the poles will reduce the risk of this happening.

***Pole spikes should pass a minimum of 5cm into the pole and be fixed at two points. Vertical poles should be capped at the ends.***




*Section of frame tent showing partial roof truss and jointing sections.*

*Interior of frame tent showing partial trusses.*

Frame tents were also found to fail under snow loads. These tents failed due to the roof trusses not being full trusses. (See previous diagram) Failure was primarily in the centre of the tent just above where the roof met the wall. In poorly made frame tents fractures were noted in the welded corner joints.

There are various qualities of coating of tent poles to prevent rusting. When the poles rust they discolour, and become rougher becoming more likely to weaken the tent fabric. They are also unsightly.

***Tents poles should be smooth coated to prevent rusting***

On some tents, there was an overlap of pole at end of ridge beyond the vertical support. If the canvas is not correctly tailored, this visibly causes a friction point which could lead to catastrophic failure.

Various poles and sticks were often used to keep the inner tent up. Unless carefully located, these sticks increase the rate of fabric failure. Some ridge tents are supplied with poles which help to stop the inner from sagging. It might be possible to design a tent with special strengthening patches so that people can upgrade themselves it with internal sticks with the risk of the sticks damaging the canvas.

**Caps on poles**

Some tents come with small plastic caps to prevent rain from passing down the poles where the spikes pass through the canvas. Not all of these are used. These can be complicated where there are two sizes for the same tent. It is interesting to note that when tent owners had used the caps, they were more likely to have looked at the instructions. Some caps were found to be made locally using sections of rubber inner tubes.

*Caps on poles with home-made replacement made from inner tube rubber.*

***If required by the design, caps on poles should be of one size per tent. These should be accompanied with simple instructions for use.***

### 6.5 Windows and doors

#### 6.5.1 Windows

Window flaps should be significantly wider than the windows themselves. Tent walls tend to be under tension leading to limited over lap and air / water leaks. The lightweight emergency tent specification includes detailing on this.

Where used in windows or other openings, Hook and loop fastening should be continuous on all sides (to prevent air leaks) and should be 50mm wide to ensure adhesion even with poor pitching. There should be ties to allow the windows to be opened.

***Hook and loop fastenings around windows should be continuous and at least 50mm wide.***

*Detail of window that does not close.*

Placing windows in the centre of the wall reduces options to put dividers across the internal space. For this reason, if dividers are to be used, then the windows should be nearer the corners.

***Ideal windows would have multiple layers; a combination of:***

- ***Clear plastic (UV stabilised) for cold climate.***
- ***Mosquito netting for warmer weather and ventilation.***
- ***Opaque layer for privacy.***

#### 6.5.2 Doors

Doors are generally left open all day, as tent occupants cannot be bothered to lace and unlace doors constantly. Overlap doors with toggle or other closing methods would be more suited to needs of tent users. Some tents have the option to fix locks to doors. The addition of locks provides additional security.

***Doors should be designed with overlaps so that even when not fastened, they are naturally closed.***

Although most canvas tents had two doors, only one of them was in use, and efforts were made to prevent drafts on the closed door. With the extended ridge tent generally the extended porch was used as front of the tent, although in some cases it was used as secure storage at the back.

***Two doors should be provided on tent designs to improve fire safety and to add to flexibility of tent use. It should be possible to close the unused doors to reduce air leaks.***

It was observed that families who did not open tents fully tended to have damper internal spaces, while those that opened their tents during the warmer and drier days had drier living spaces.

***Doors should be designed so that they can be opened wide to ventilate the tent.***

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### 6.6 Packaging

At distributions in Pakistan, many tents had to be carried significant distances up mountains by hand. Tents in monolithic bags were thus difficult to transport.

Experience from warehousing of tents without a Hessian/jute covering is that stacking is very difficult as they are too slippery. Addition of a rough sack covering prevents damage during handling and warehousing.

***Tents should be packaged in parts so that each part can be carried by one person.***

- ***Poles should be packaged in a bag separate from the canvas.***
- ***The entire tent should be packaged in one bag complete with instructions and repair kit.***
- ***The entire tent should be wrapped in waterproof bag***
- ***The waterproof bag should be wrapped in a Hessian / jute sack to improve safety of stacking in warehouses and in transport***

#### 6.6.1 Repair kit

Many tents were found to have makeshift repairs following damage they had sustained in use. These repairs were of variable quality, in part hampered by lack of suitable materials. As an example some stitching of damaged canvas was found to have been done with thread that was either too thick or too thin causing the repair to be ineffective or even damaging to the tent. Providing appropriate tools and materials for repairs would improve the quality of repairs made.

***A basic repair kit should be included with the tent. It should include:***

- ***Needle.***
- ***Thread.***
- ***Spare piece of fabric for fly.***
- ***Spare piece of fabric for flooring.***

## Annex A - mission itinerary

Day 1. Khagan valley – visit 3 family compounds at 3 sites.

Day 2 Balakot – visit 9 family compounds at 5 sites

Day 3 - Kastara and Jaba camps

Day 4: Thakot: visit 2 villages (4 family compounds) and 1 roadside encampment (two families)

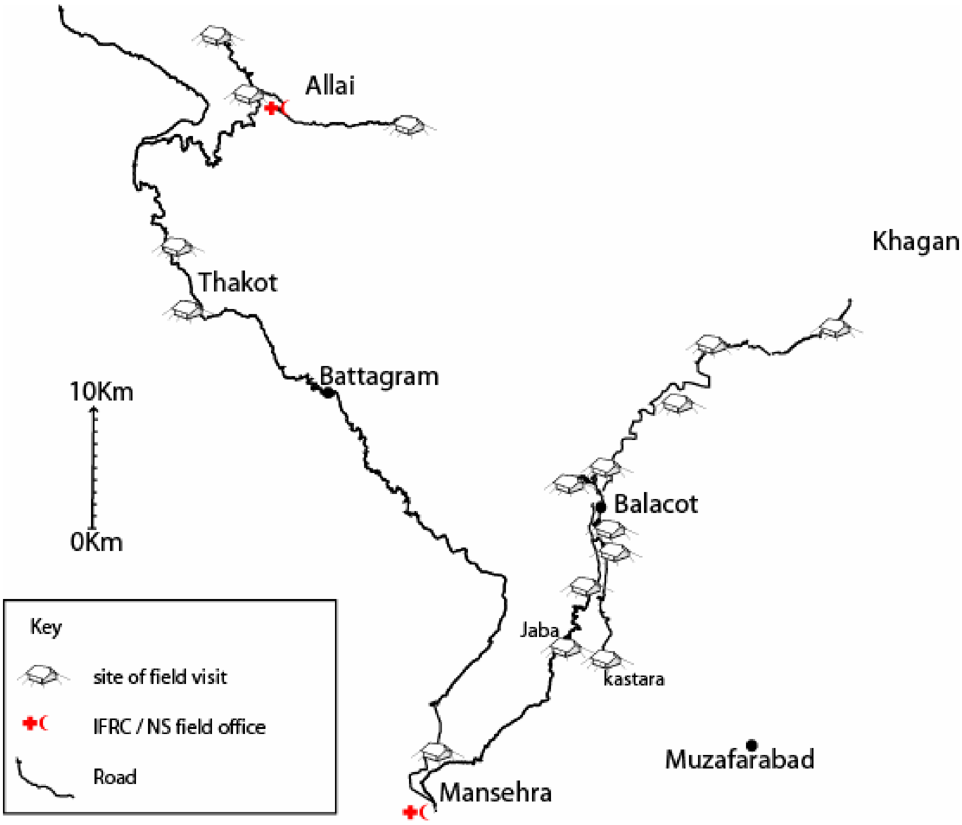
Day 5: Allai: Tulus and Tandol community meeting. Meeting with CARE International

Day 6: Allai: Gangwal

Translator: Abbas Ishan

## Annex B - Map

Key parts of NWFP visited, including Roads traveled and locations visited.



## Annex C - What is a winterised tent?

Below is a working definition of a winterised tent taken from “technical guidelines for winterization strategy”, Emergency Shelter cluster South Asia Earthquake, Pakistan (Dec’05-Jan’06).

**Winterised tent**

A winterised tent must be made of **waterproof canvas**, and must have a **strong supporting frame**. It must provide a **minimum of 12m$^2$** (130ft2) covered area. Additionally, a winterised tent has the following components:

**Fly sheet**

- separate fly sheet, usually made from canvas, which fits over the inner tent.

**Flue manifold.**

- The inner tent and flysheet each have a metal plate with a hole in it. These plates are sewn in or fixed into a canvas pocket. This allows for a stove with a chimney to be placed inside the tent without the risk of the flue pipe igniting the canvas when hot.

**Structural supports.**

- The poles which form the vertical supports and the ridge beam should be made of a thick gauge steel (min 1.5mm) and with an external diameter of 35-50mm. This gives suitable structural resistance to both high winds and snow loading.

**Inner lining.**

- The inner tent may have a light cotton (‘desouti’) lining.

**mud flaps / valences**

- The tent must have rot proof mud flaps of suitable quality and length to allow the tent to be dug into the ground.