ICRC

End of Project Report

ECO DESIGN TARPAULIN

Version No.: 2.1

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Author(s): Patrick OGER

Validated by: See approvals section

The Eco Design Tarpaulin Project started on May 1st 2021.

This End of Project Report is updated with the last Steering Committee outputs held on December 12th, 2023

Table of Contents

1 DOCUMENT ADMINISTRATION

1.1 Document History

Version No.	Date	Issued by	Reason
1.0	07/12/2023	P.OGER	First draft sent prior to final project meeting
1.1	09/12/2023	P.OGER	Updated draft prior to final project meeting
1.2	11/12/2023	P.OGER	Updated with Carmen's feedback
2.0	15/12/2023	P.OGER	Updated draft after the Steering Committee meeting
2.1	27/12/2023	P.OGER	Final version

1.2 Associated Documents

Document	Date	Author
Tarpaulin Project update n°1 v4.0	09/11/2021	Patrick Oger - ICRC
Tarpaulin Project update n°2 v1.5	09/05/2022	Patrick Oger - ICRC
Tarpaulin Project update n°3 v1.0	02/02/2023	Patrick Oger - ICRC
RISE final report Eco-design tarpaulin_signed	02/12/2022	Ida Östlund - RISE
Project note Biobased polyethylene FINAL	16/11/2022	Anna Jansson - RISE
Project note Biodegradable plastics FINAL2	01/07/2022	Anna Jansson - RISE
Project note Recycled Polyethylene FINAL	22/11/2022	Anna Jansson - RISE
LCA new tarpaulin 2022_12_02	02/12/2022	Yoon Lin Chiew - RISE
WP1 LCA raw material_Results_Final	15/06/2022	Yoon Lin Chiew - RISE
9 x Meeting minutes steering committee meetings n°1 to n°9	2021/2023	Patrick Oger - ICRC
Tarpaulin RD_recycling plastic_2022-12-02	02/12/2022	Patrick Oger - ICRC
231013_Eco-Tarpaulin test report. Final	02/10/2023	SRU/AI-CRL, Shelter Research Unit / Aide Internationale Croix Rouge Luxembourgeoise
NIGER_Tarpaulin post distribution monitoring ICRC	12/2023	ICRC ECOSEC Niger

Tarpaulin specification, updated 2023/12	12/12/2022	Patrick Oger - ICRC

1.3 Approvals

This document requires the following approvals.

Name	Title	Date	Signature
Carmen GARCIA DURO	ICRC SSCA Project Manager		
Ela SERDAROGLU	IFRC Head of Shelter dpt		
Ammar AL-MAHDAWI	UNHCR Senior Technical Shelter Officer		

1.4 Glossary / Project Specific Abbreviations

Abbreviation	Term	Description
SSCA	Sustainable Supply Chain Alliance	ICRC Project to enhance sustainable supply
SPC	Standard Products Catalogue	Web publication of all compiled standard specification
UNHCR	United Nation High Commissioner for Refugies	Project partner
QSE	Quality Social Environmental	Global sustainable approach of the supply
QSE group	Quality Social Environmental Procurement Group	Inter agencies working group with ICRC, IFRC, IOM, MSF, UNHCR, UNICEF
ICRC	International Committee of the Red Cross	Project owner
IFRC	International Federation of Red Cross and Red Crescent Societies	Project partner
IOM	International Office for Migration	
MSF	Medecins Sans Frontieres	
RISE	Research Institute of Sweden	Project partner
LCA	Life Cycle Assessment	Measure the whole product life impact.
GHG	Green House Gazes	Emitted gazes that increase the global warming

2 EXECUTIVE SUMMARY

The demand for a sustainable approach in procurement has created pressure on the humanitarian supply chain. During the last 10 years, the technical specifications for the major relief supplies have started to evolve to respond to this new requirement.

In the 1990's, the specification for a tarpaulin adapted to the emergency aid operations were developed by a consortium of Organizations including UNHCR, MSF, ICRC, and IFRC as major stakeholders. These specifications have successfully served until now as a reference for the supply of tarpaulins in the humanitarian Organizations.

Even though the environmental criteria were not absent from that product development, a higher level of requirement is now demanded for consumers goods, and the tarpaulin specification need to be revised in that aim.

On May 1st, 2021, the ICRC, UNHCR, and IFRC have launched a Research and Development project to design a new tarpaulin specification with a lesser environmental impact.

A panel of more than 90 stakeholders was regularly consulted as source of information and peer review, including humanitarian actors, manufacturers, universities, laboratories.

Through the Life Cycle Assessment handled by the Research Institute of Sweden (RISE), the different steps of the product life were analyzed for comparing potential alternative products on reliable grounds. Several scenario cases were identified, particularly for the end of life. All possibilities to reduce the environmental impact were screened and described in a proposal for enhancing the product specification.

The life cycle assessment included eleven impact categories from resources depletion, global warming, and toxicity in all types of environment.

The research included deep investigation on biodegradable, bio-sourced, and recycled materials. As a result, in the current context and until further scientific and technical evolution, biodegradable and bio-sourced materials were excluded from the potential alternatives due to too many uncertainties and many negative impacts. Recycled material was approved for its potential impact reduction, and included as an option only, due to the market scarcity of reliable sources of recycled PE.

In addition, the Research Institute of Sweden did a screening of the industrial and commercial products, from several sectors including building materials and packaging materials, and identified potential options, included in the alternative product development.

In parallel, a long-term laboratory test (equivalent to 10 years real life) was performed to measure the UV resistance of the current tarpaulin. This test demonstrated the extremely high UV resistance of that tarpaulin compared to the tarpaulins one can find on every market. This excellent and essential performance will be reconducted in the new tarpaulin specification.

The new product requirements were set based on the stakeholder's feedback, user's survey results from Mali and DRC, LCA results, laboratory testing results. Once validated by the Steering Committee, those requirements were sent to partners from the industry in the form of a Request for Proposal to design an alternative product.

After two rounds of proposals, studied and tested in detail, the new technical specifications were issued. These new specifications were compared to the current ones through a Life Cycle Assessment. Achievements in reducing the environmental impact were confirmed, with the following specifications:

- Introduction of 15% recycled PE will reduce by 8% the impact on global warming and fossil resources depletion
- Reduction of 14% of the weight will reduce by 14% the overall impact
- Extended life-time with a stronger PE material and high UV resistance can potentially reduce 50% or more of the overall impact
- Recycling at the end of life could potentially reduce up to 78% of the overall impact, thanks to the extremely durable UV resistant PE that allows collecting waste even after decades without degrading into microplastics.

Four major tarpaulin manufacturers were requested to produce a batch of those new tarpaulins for testing at field level and at laboratory level.

The laboratory test confirmed the achievability of those specification, with some minor adjustments in the newly introduced criteria. It was also confirmed that the fire safety is achievable without toxic chemical additives. Laboratory test on large samples, supported by real size test on PE tents, demonstrated the same behavior to large fire from tarpaulins with and without fire retardant additives. This allows the yearly suppression of 1000 tons of harmful chemicals.

The field testing was handled by the Shelter Research Unit of the Luxembourg Red Cross in Niger, involving 30 volunteer beneficiaries, representing 30 households in 3 locations. An additional blind test was handled by ICRC in Niger with a distribution to 50 beneficiaries without specific information on the new tarpaulin. Results came out from both tests with highly positive results (94% satisfaction).

The Project ended in December 2023 with the release of the final specification for the new tarpaulin including mainly the reduction of material quantity and the increase of durability. Moving to these new specifications for the 3 million of tarpaulins distributed every year will **reduce the CO2eq emissions by 69'000 tons** per year in addition to the reduced toxic pollution and a reduced usage of resources.

Further recommendation: Even though using recycled raw material and reducing the weight has a clear positive impact, the large potential impact reduction is linked to the re-use and the recycling at the end of life. Further investigations on recycling should be conducted.

In addition, the quality of the distributed tarpaulins must be guaranteed by a strong and reliable quality management system. During the project, it was identified as a challenge for the organizations procurement services to perform sufficient and efficient quality control.

With many thanks to all stakeholders.

3 PROJECT STEERING COMMITTEE

The Steering Committee meeting n°10 (SC10) was held on December 12th, 2023

Presents, Steering Committee members:

- Ammar AL-MAHDAWI, UNHCR Senior Technical Shelter Officer, Technical Support Section
- Carmen GARCIA DURO, ICRC SSCA Project Manager
- Ela SERDAROGLU, IFRC Head of Shelter dpt
- Patrick OGER, Project Manager

Presents, invitees:

- Pavlos Tamvakis, ICRC Head of WhatHab Project
- Daniel Ledesma, Luxembourg Red Cross Head of Shelter dept.
- Afshin AMINI, ICRC Quality Manager
- Christoph HERBY, ICRC Ecosec, Deputy HoU
- Hui Liu, ICRC Lead Buyer for Tarpaulin and EHI
- Emily Zhang, IFRC Lead buyer
- Juan Galvez, IFRC Global Lead – Supply Chain Environmental Sustainability

Apologized:

- Anna Maria Liwak, ICRC Sustainable Development Specialist
- Alka KAPOORSHARMA, IFRC Global Lead, Procurement

The outcomes of the SC10 are included in this report. The meeting minutes were shared with the SC members and all participants.

4 BACKGROUND

4.1 Project outcomes 2021-2022

The previous phases of the project produced the proposed new tarpaulin specification, with the aim to reduce the environmental impact of tarpaulins distribution. See Project report n°1

The environmental impact reduction of the tarpaulin distributions was confirmed by the comparative Life Cycle Analysis of the current and the new proposed tarpaulin. See Project reports n°2 and n°3

4.2 Project outcomes 2023

This last phase verifies the achievability and the scalability of the new specification, and allows the release of the specification for the future procurement. Result included in this project report.

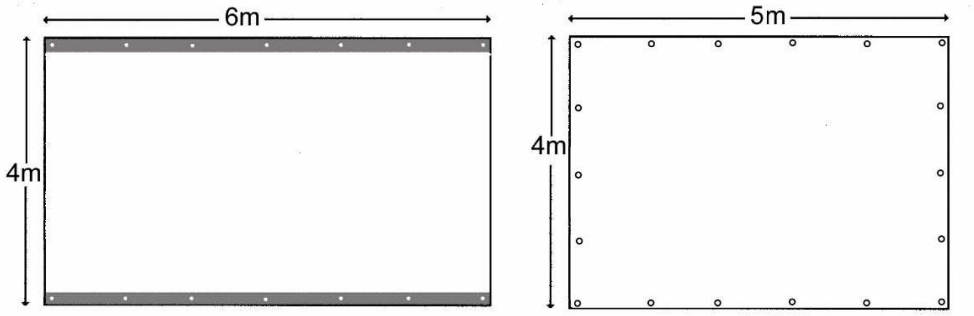
4.3 New tarpaulin technical specification sheets

After the development of the new alternative specification, the steering Committee agreed on the main specification.

There were still questions on the different fixation systems. One type derived from the current ICRC/IFRC tarpaulin with a reduced quantity from 6 reinforcement bands to 2 bands only. The second derives from the UNHCR current type with a peripheral hem with an inserted rope and 20 aluminum eyelets.

In the absence of final decision on the proposed new fixation system, it was decided to send the two types to the field for testing.

The two different current sizes of the two types were also included in the field test (4x5m and 4x6m).



5 SITUATIONAL ASSESSMENT

Detailed results are available in the different reports, see list of documentation in part 1 above.

Sixty eight tarpaulins from both types, 6x4m with bands, and 5x4m with eyelets, were produce by four major manufacturers. Sixty were sent to the field and eight were sent to the laboratory.

One hundred of the 6x4m new tarpaulin were distributed in Niger by the ICRC, for a blind test.

5.1 New tarpaulin validation at laboratory

Laboratory tests were performed to confirm that the new specification are reached.

Samples of the two types of tarpaulin from four manufacturers were sent to the approved laboratory, Centexbel, to verify the following criteria:

- UV resistance
- Fire resistance (FR) under EN test and under CPAI test
- Fire resistance additives search
- Mass
- Tensile strength
- Tear strength
- Fixation points tensile strength
- Puncture resistance
- Blade cut resistance

The objectives of the laboratory tests:

1/ Verify the fulfillment of the new specification for the most essential criteria, where the changes have been made from the previous specification

2/ Measure the influence of the FR additives on the fire resistance

3/ Measure the influence of the FR additives on the UV resistance

5.2 Laboratory test results

Laboratory test result summary

criteria	Results
UV resistance	1 pass out of 2 samples
Fire resistance (FR) under EN and under CPAI	5 pass out of 5 samples
Fire resistance additives search	From 0% to 13.8% in mass
Mass	6 pass out of 8 samples
Tensile strength	8 pass out of 8 samples
Tear strength	6 pass out of 8 samples
Fixation points tensile strength	1 pass out of 8 samples
Puncture resistance	4 pass out of 8 samples
Blade cut resistance	0 pass out of 8 samples

Eco-Design Tarpaulin Project ICRC/IFRC/UNHCR 2023

Laboratory tests detailed results on samples from the batch sent to Niger for field test

Tarpaulin 4x6 m with side bands

ICRC ref \ test	UV test + tensile	Fire test EN + fire test CPAI	XFR + FTIR (search additives FR)	Mass mini/maxi	Tensile warp/weft	Tear warp/weft	Fixation strength	Puncture	Blade cut
requirements	maximum loss: 5%	D-s2-d2 (no CPAI)	No FR additives	160/180	750/750	200/200	1000	45N	minimum 3.5
SAMP23046-1	NO test	B-s1-d0	0%	177g	1155/1162	290/300	753	49N	1:2.6; 2:3.4
SAMP23053-1	NO test	B-s1-d0	0.68% Br; 0.23% Sb	174g	1175/1223	240/260	962	55N	1:3.1; 2:3.1
SAMP23055-1	warp loss: 0.5% weft loss: 0%	B-s1-d0 (CPAI fail)	0.67% Br; 0.36% Sb	177g	1098/1044	270/260	863	44N	1:2.9; 2:2.8
SAMP23062-1	NO test	B-s1-d0	0%	190g	1069/789	140/160	1033	56N	1:2.9; 2:2.6

Tarpaulins 4X5 m with eyelets

ICRC ref \ test	UV test + tensile	Fire test EN + fire test CPAI	XFR + FTIR (search additives FR)	Mass mini/maxi	Tensile warp/weft	Tear warp/weft	Fixation strength	Puncture	Blade cut
requirements	maximum loss: 5%	D-s2-d2 + CPAI	FR additives	160/180	750/750	200/200	1000	45N	minimum 3.5
SAMP23046-2	NO test	NO test	0%	172g	1158/1036	290/310	629	29N	1:2.9; 2:2.8
SAMP23053-2	NO test	NO test	4.9% Br; 1.4% Sb	181g	1197/1215	280/270	640	36N	1:2.6; 2:2.6
SAMP23055-2	warp loss: 3.9% weft loss: 6.7%	B-s1-d0 + CPAI pass	8.8% Br; 5% Sb	171g	1081/885	210/250	668	47N	1:2.0; 2:2.1
SAMP23062-2	NO test	NO test	3.9% Br; 1.8% Sb	172g	1107/919	170/220	858	44N	1:3.4; 2:3.1

5.3 Test results interpretation for the basic criteria

5.3.1 Mass, tensile strength and tear strength

The test confirmed the tarpaulin passes those criteria, even though 2 samples from the same manufacturer did not pass the tear test, the three other manufacturers had very good results on their 2 samples.

For 6 samples the mass is correct, one does not pass by a very small defective percentage, only one sample is too far above the requirement.

5.3.2 Puncture test

Half of the samples passes the minimum requirement, two failed with a very small gap, and two really failed. A point of concern is that the samples from the same manufacturer may pass or fail without clear indicators of the difference between the two samples. The type of test does not seem adapted to that type of product because the product is not homogeneous. If the sharp point hits the tarpaulin test piece between two yarns or right in the middle of the yarn, the test result will be very different.

It is recommended to remove that test from the specification.

5.3.3 Blade cut test

All the samples failed at this test. The minimum requirement is probably not realistic considering the type of product.

At the contrary with the puncture test, this blade cut test is more adapted to a non-homogeneous product like this tarpaulin, because it applies on a line instead of a point, the application line is diagonal with the warp or the weft, and there are 6 lines on each test pieces, which makes a reliable mean value.

It is recommended to keep this test in the specification, and to adjust the minimum requirement to 2.5.

5.4 Test results interpretation for the Fire Resistance

There are two types of fire resistance test currently in use for the tarpaulin specification:

5.4.1 EN13823

Title: Reaction to fire tests for building products - Building products excluding floorings exposed to the thermal attack by a single burning item.

Description: A test piece of 1.5m x 1.5m exposed vertically and forming a wall corner is exposed in the corner to a large fire of 30kW for 20 minutes.

5.4.2 CPAI84-6

Title: Specification for flame resistant materials used in camping tentage, part 6 wall and top material.

Description: Test pieces of 70mm x 300mm vertically clamped in a metallic frame are exposed to a single flame for 12 seconds.

5.4.3 ICRC/IFRC FR requirements

The ICRC/IFRC specification includes the EN 13823 test procedure only. The test measures the heat production, the smoke production, the lateral (horizontal) flame spread and falling flaming droplets and particles. The minimum requirement is the obtention of the level D-s2-d2 + LFS 4 minutes, which means:

- Reach level D of flammability out of 6 levels ranked as A, B, C, D, E, and F, the A being the less flammable
- Reach the level s2 in smoke production out of 3 levels ranked from s1 to s3, the s1 being the less producing smoke
- Reach the level d2 in flame droplets production out of 3 ranked from d0 to d2, the d0 being the less producing of flame droplets
- In addition, the time to consume the large wing of the wall corner in the case it catches fire must be minimum 4 minutes.

5.4.4 UNHCR FR requirements

The UNHCR specification also includes the EN 13823 with the same requirements as ICRC/IFRC and includes the CPAI84-6.

The CPAI 84-6 test is passed when:

- Maximum average after flame time before self-extinguishing: 10 seconds
- Maximum individual after flame time before self-extinguishing: 30 seconds
- Portions or residues falling self-extinguish immediately
- Maximum average damaged length: 190mm
- Maximum individual damaged length: 255mm
- The CPAI test is conducted on samples in original state, after leaching, and after UV exposure.

5.4.5 FR additives vs FR resistance

All the samples pass the EN test requirements for the fire resistance, reaching a much higher level than required (required: level D-s2-d2, achieved: level B-s1-d0). The samples without any additives all pass the test. This demonstrates the low ability of this PE material to spread fire on large pieces of plastic.

In addition, the sample with a very high concentration of additives performs similarly to the others on large fire test. This demonstrates that even a nonflammable plastic does melt when exposed to a large fire. There is no difference in the reaction to the large fire test between a sample that contains FR additives and a sample that does not contain FR additives.

This is visible on the below photos of the samples during and the end of the EN test.

This is also visible on the real size test performed by ICRC in 2016, visible here:

https://www.youtube.com/watch?v=Y7Frz-MlqsY

Only the sample with high concentration of additives passes the CPAI test. One may conclude that the CPAI test is not adapted to this type of material for this usage. This test was established in the 1980s when tent walls and tops were often made of polyester and cotton, this mix being extremely flammable.

Sample 23046-1 (no additives)

sample 23062-1 (no additives)

missing photo from laboratory

Sample 23053-1 (0.68% Bromide 0.23% Antimony)

Sample 23055-2 (8.8% Bromide 5% Antimony)

Sample 23055-1 (0.67% Bromide 0.36% Antimony)

5.4.6 FR additives vs UV resistance

On two samples from the same manufacturer, one with 14% FR additives and one with 1% FR additives, the impact of the FR additives appears clearly causing a degradation of the UV resistance where the FR additives are presents at a high percentage.

The low percentage does not affect the UV resistance.

The sample with high concentration of FR additives does not pass the UV resistance minimum requirement.

The information given by all manufacturers since years is confirmed by this test result: FR additives are reducing the UV absorbers efficiency.

5.4.7 Comments on the use of FR additives

The laboratory test results, and similarly the previous real scale fire tests, show that the FR additives does not make a real difference in regard to the fire safety of the product. Even without additives this PE tarpaulin does not easily propagate a fire.

From the environmental perspective, the amount of chemicals used as FR additives is not neglectable. Considering the 3 million of Tarpaulins distributed every year, the FR additives represent an annual usage of 468T to 1056T of Bromide and 168T to 600T of Antimony.

The test also confirmed the degradation of the UV resistance due to the presence of FR additives, which will reduce the life span of the tarpaulin, therefore increasing the impact on the environment.

Referring to the original tarpaulin LCA, based on 6% FR additives, specific levels of toxicity are identified as per the table below:

Impact category	Unit	Woven PE tarpaulin - Main body (6x4m)	Six bands	Flame retardant	Eyelets	Rope
Resource use (minerals and metals)	kg Sb eq	8,17E-05	7,26E-06	0,073	2,70E-07	1,40E-06
Resource use (fossil fuels)	MJ	310,58	32,17	27,12	2,48	7,0
Global warming (GWP100a)	kg CO2 eq	11,23	1,05	1,83	0,27	0,22
Ozone layer depletion (ODP)	kg CFC-11 eq	3,97E-07	3,32E-08	1,94E-07	8,11E-09	3,60E-09
Human toxicity	kg 1,4-DB eq	5,15	0,43	26,73	0,17	0,08
Fresh water aquatic ecotox.	kg 1,4-DB eq	4,00	0,31	31,53	0,20	0,06
Marine aquatic ecotoxicity	kg 1,4-DB eq	9 033	702	33 891	788	131
Terrestrial ecotoxicity	kg 1,4-DB eq	0,0087	0,0007	0,0103	0,0005	0,0001
Photochemical oxidation (summer smog)	kg C2H4 eq	3,67E-03	3,06E-04	4,60E-04	9,41E-05	4,22E-05
Acidification	kg SO2 eq	0,043	0,004	0,013	0,002	0,001
Eutrophication	kg PO4--- eq	0,012	0,001	0,022	0,0004	0,0002

Comparison of a tarpaulin with two bands, with FR and without FR additives:

- Resources and mineral use: 0.000084 vs 0.073 = 811 times more impact with FR
- Human toxicity: 5.3 vs 26.73 = 5 times more human toxicity with FR
- Fresh water toxicity: 4.1 vs 31.53 = 7.7 times more toxicity with FR
- Marine water toxicity: 9268 vs 33891 = 3.6 times more toxicity with FR
- Terrestrial toxicity: 0.0089 vs 0.0103 = 86 times more toxicity with FR

5.5 New tarpaulin validation at field level

5.5.1 Field test organization

The Luxembourg Red Cross, through the Shelter Research Unit, together with the Red Cross of Niger, conducted the validation testing of the two tarpaulin types.

The tarpaulins have been tested at field level with setting up real size shelters in places where the current PE tarpaulin is in use. The shelters are being used by people to compare the two proposed types, and analyze the pros and cons.

The tests were conducted in three regions of Niger: Diffa, Maradi and Tillabery.

5.5.2 Conclusion of the field test

Analysed criteria: Opacity, easiness of use, comfort, protection, durability, resistance, reuse, and overall satisfaction.

Level of satisfaction: 93% and 94% for the two types respectively.

The field test concludes that both tarpaulins have a degree of acceptability: **EXCELLENT**

Beneficiaries value most positively the fixation system with metal eyelets.

Beneficiaries value most positively the dimensions of the 4m x 6m tarpaulin.

Report abstract:

2.3. On a scale of one to three, how would you rate the fastening system?

MODEL	Excellent	Acceptable	Bad	positive percentage	neutral percentage
M1 (4 x 5) - Eyelets	13	1	1	86.7%	1.5%
M2 (4 x 6) - Holes	2	11	1	14.3%	78.6%
M2 (4 x 6) - Reinforcement bands	7	6	1	50.0%	42.6%

5.5.3 Additional field test with ICRC

The ICRC has included 100 pieces of the new tarpaulin in a distribution in Niger. This is a blind test to collect feedback from users without preconception.

Thanks to the ICRC team in Niger, the report came right on time despite the challenges encountered. Most importantly, we note an overall satisfaction with the quality of the tarp, and no “red flags” relating to the design specification or materials.

The question on size is often mentioned. It is recommended to maintain the normal dimensions that are a humanitarian standard, while encouraging teams to distribute multiple tarpaulins for large households.

This blind testing conducted by ICRC in Niger helps to build confidence that the steering committee is making sound decisions with regards to the new specifications.

5.6 Test results interpretation for the fixation strength

5.6.1 Test of fixation points at laboratory

Laboratory test on the different fastening systems were performed in 2 phases of the project.

First tests were performed at RISE with 15 different fixation types. It showed a systematic failure of all fixations systems involving a hole in the tarpaulin, whether the hole is or is not equipped with an eyelet. The strongest fixation system was the rope and stone system, without hole (see project report n°3).

It was noted that the reinforcement bands, or the hemmed side provide extra strength.

Second fixation tests were performed at Centexbel with 8 samples from the batch sent to Niger for field test.

For the bands, 3 failed out of 4 samples, with a failure between 4% and 25% below the minimum requirement.

For the eyelets, all failed with a failure between 14% and 37% below the minimum requirement.

This failed test confirm the difficulty to reach a high level of strength when perforating the tarpaulin. The presence of the band brings some additional strength, even though it is not reaching the expected result.

5.6.2 Test of the fixation points at HQ

Practical testing of samples with proposed new fixation systems were performed during the SC8 at ICRC Logistic Center on March 15th,2023.

These tests confirmed the failure to reach 1000N for both the metal eyelets and the holes in bands. All failed between 900N and 1000N.

It confirmed the high traction resistance of the rope and stone system, without hole, passing 1350N without failure (maximum capacity of the testing equipment at ICRC).

Conclusion of the HQ test on fixation systems:

- The eyelets do not provide any extra strength compared to a plain hole.
- The size of the hole and the shape of the hole does not make a major difference.
- The fixation that does not perforate the tarpaulin is the strongest by far.
- The double layer edge (band or hem) provides extra strength in all cases (with or without hole).

5.6.3 Price and production impact of different fixation systems

The four manufacturers provided data on price and production capacities, for various fixation systems.

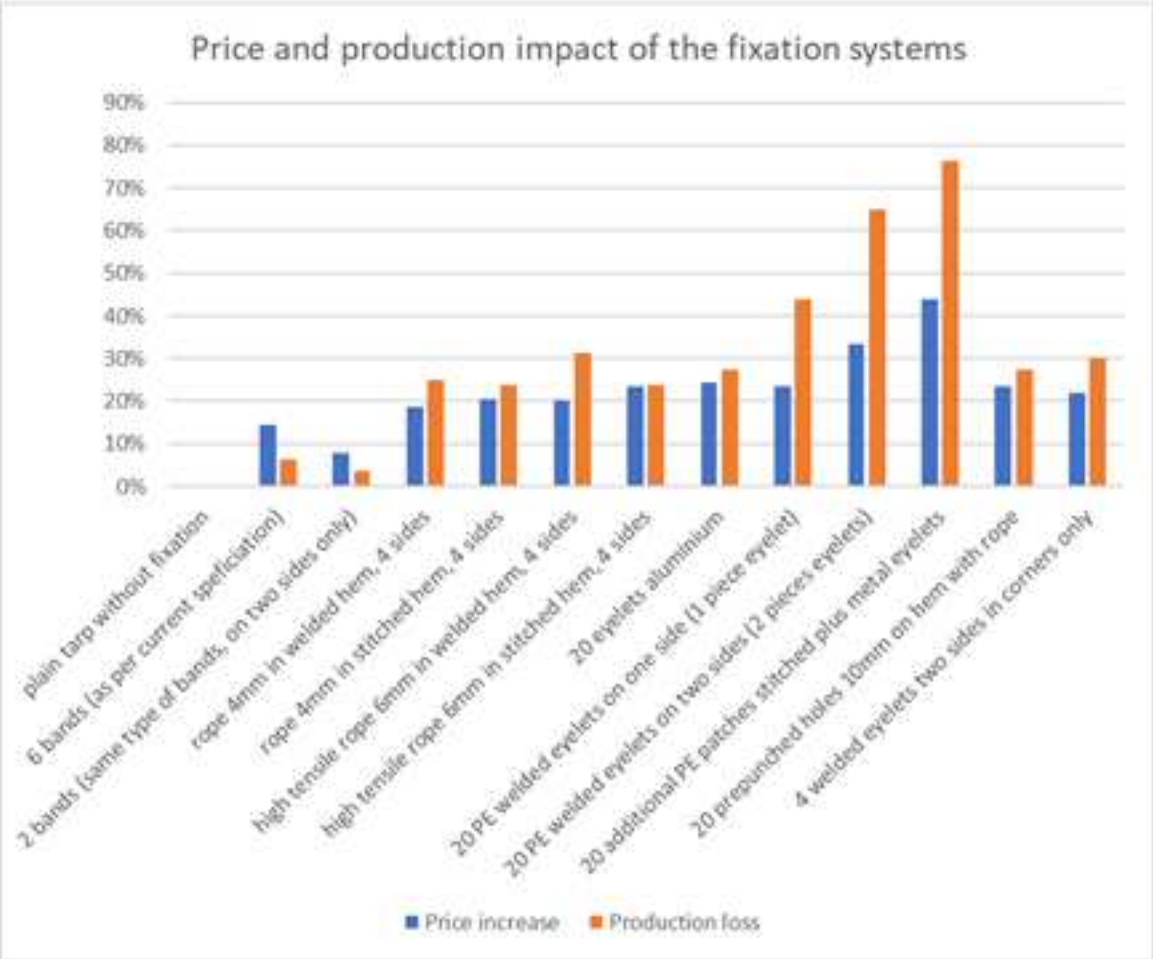
The graph below shows the increase in price and the loss of productivity depending on the choice of fixation system.

- The fixation system with 6 bands generates a cost of 15% and 6% productivity loss.
- The fixation system with 20 aluminium eyelets and rope plus hem generates a cost of 34% and 53% productivity loss.

- The proposed fixation system with 2 bands generates a cost of 8% and 4% productivity loss.

In other terms:

- Compared to the current ICRC/IFRC type, the new proposed tarpaulin offers 6% price decrease and 2% increase of productivity.
- Compared to the current UNHCR type, the new proposed tarpaulin offers 25% price decrease and 32% increase of productivity.



5.6.4 Environmental impact of different fixation systems

The bands with holes increase the impact by the weight of the bands only. That makes 3.5% increase of impact.

The hem plus rope and eyelets increase the impact by the weight of the rope and the hem, and by the addition of aluminium components. Furthermore, it complicates the recycling as it requires separating the different materials before recycling. The hem makes an increase of 4% in weight, the rope makes an increase of 5% in weight.

5.7 Final new tarpaulin specification

5.7.1 Recommendations for the new technical specification

Based on this Research and Development Project outcomes, the project recommends establishing the new tarpaulin specification as follow:

From the current standard tarpaulin specification,

- Keep the same material (PE), include 15% of recycled material as a preferred option
- Reduce the weight of the base tarpaulin from 190g to 170g
- Reduce the number of reinforcement bands from 6 to 2, only on each side lengthwise, with holes of 8mm every meter
- Increase the tear strength minimum requirement from 100N to 200N
- Increase the tensile strength minimum requirement from 500N to 750N
- Increase the tensile strength of the fixation points from 750N to 900N
- Do not include the puncture resistance test (not adapted)
- Include a blade cut resistance of 2.5
- Exclude fire retardant additives, keep the FR requirement as per current EN test
- Print "recycle" logo, "do not burn" logo, and "user guide" on the tarpaulin

Remark: One of the 4 manufacturers indicates that for easiness of production there should be at least 4 bands, in order to keep a straight roll easier to handle. This is in the case where the tarpaulin is made from 2 rolls of 2m wide welded side to side to make the 4m wide product. This cannot be included in the specification, but nevertheless can be taken into consideration by the procurement services.

5.7.2 Final new specification

Here after the technical specification for two types of tarpaulin:

- Recommended from this R&D project: Tarpaulin 4m x 6m with 2 bands, fire resistant with no FR additives
- UNHCR preferred choice: Tarpaulin 4m x 5m with hem, rope, and metal eyelets, fire resistant with FR additives

Plastic Tarpaulins 4x6m with two reinforcement bands

Material	
Material for the tarpaulin	Woven high-density polyethylene (HDPE) black fibres fabric laminated on both sides with white low-density polyethylene (LDPE) coating. Preferably includes up to 15% recycled PE.
Reinforced fixation points	Two bands of 75mm +/-3% width made of woven black HDPE fibres fabric and coated with grey LDPE on the outside. Seven holes of 8mm on each bands at 1m +/-5% intervals, positioned in the centre of the bands, punched through the band and the tarpaulin. Position of the two bands and the holes as per drawing below. Side bands can be positioned at maximum 10mm from the edge.
Manufacturing quality	The woven base as well as the coating must be homogeneous. The black fibres must be straight in wrap and weft and must cover the entire surface of the tarpaulin.
Recycled PE definition	As described by the Circular Plastic Alliance of the EU commission in EN 45557 and the US Federal Trade Commission Green Guides in accordance with ISO14021 principles, recycled plastic includes post-industrial and post-consumer recycled waste, it excludes reworked material. In this last case, even though it is encouraged to re-use scrap from tarpaulins production, it does not count as material from recycled origin.
Strength at state of origin and after UV exposure	
Test pieces for tensile and tear tests.	Cut all test pieces parallel to the direction of the fibres, in warp and in weft. The fibres should run from one end to the other end of each test piece.
Tear strength at state of origin	Minimum 200N under ISO 4674-1B 2003, with a test piece of 200x200mm as described in ISO 4674 annex B.
Tensile strength at state of origin	Minimum 750N and 15% to 35% elongation in warp and weft under ISO 1421-1.
UV resistance ASTM G53 ISO 1421-1	Apply 1500 hours UV under ASTM G53/94 (UVB 313 nm peak). Maximum 5% loss of strength compared to the original tensile strength of the actual product.
Cut resistance EN 388-6.2	Minimum index 2.5 Test 2 test pieces from one sample.
Tensile strength in the fixation points	Minimum 900N when pulling inside the fixation points as per ISO 1421-1, pulling perpendicular to the tarpaulin edge with a hook of 8mm wire diameter. Test 3 pieces of 200mm wide by 500mm long from each side of the tarpaulin.
Welding and strength at state of origin	Only one welding allowed, in the middle of the sheet, lengthwise. The tarpaulin tensile strength crosswise at the place of the welding under ISO 1421-1 must be minimum 50% of the original value of the actual product.
Size, weight, colour, opacity, fire resistance	
Width	4 m ± 1% net width

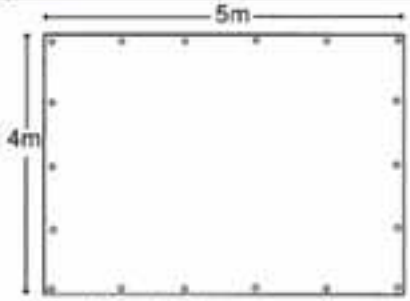
Length	6m minimum net length
Specific weight of the tarpaulin plain sheet.	170g/m² ± 10g under ISO 3801 (equivalent to 160g/m² minimum to 180g/m² maximum)
Weight of the complete tarpaulin	Total weight of the 24m² tarpaulin: 3.960kg min to 4.512kg max Specific weight of the bands from 150g/ m² to 200g/m²
Flame retardant EN13823+A1	Minimum class D, s2, d2. Minimum time to reach large wing external edge: 4minutes (LFS) Presence of FR additives (bromine, antimony) is not permitted
Colour ISO 105J01	Inner black fibres to ensure opacity. White coating on both sides of the sheet as per: L.a.b Coordinates: minimum "L": 82 "a" value between -1.7 and +1.5 "b" value between -4.5 and 0
Opacity measured as minimum reflection and maximum transmission, in the range of visible light and near infrareds. ISO 13168-1	Values should be measured respectively from 350 to 750nm, and from 750 to 2500nm wavelength. The result is the average of the averages in each range. Minimum total reflection: 35% Maximum total reflexion: 55% Maximum total transmission: 5% Absorption: remaining balance to reach 100%
Marking, packing	
Printing 1	Long lasting indelible printing in black colour of the manufacturer name, the month and year of production (Letters of 2.5cm high +/10%) printed on the sheet, not on the bands. Customer logo on request.
Printing 2	Long lasting indelible printing in black and grey colours of the recycling signs for LDPE and HDPE, of the user's guide, and of the "do not burn" sign.
Bale dimensions	Length: 600mm; Width: 400mm; Height: 180mm (all +/-20%) There must be 5 tarpaulins per bale
Bale marking	As per indicated in contract.
Bale protection	The bale must be wrapped with a piece of the same tarpaulin material. The wrapping must be properly folded, closely tight to the bale content, making a well-shaped cubic bale. The tarpaulins are not individually wrapped.
Bale strapping	The bale must be strapped with 2 heat-sealed plastic straps for the length and 2 for the cross.

Drawing is not to scale

Plastic Tarpaulins 4x5m with metal eyelets

Material	
Material for the tarpaulin	Woven high-density polyethylene (HDPE) black fibres fabric laminated on both sides with white low-density polyethylene (LDPE) coating. Preferably includes up to 15% recycled PE.
Reinforced fixation points	Reinforced rims with a folded hem welded by heat sealing on all sides, (or 2 sides heat sealing and 2 sides double stitching), and a 3 to 5mm diameter PE or PP (flexible materials) rope on the edge, inside the hem, 1000 denier minimum. Provided with 18 aluminium eyelets or equivalent on four sheet sides of the single sheets at 100 cm ±5 cm centre to centre, providing very strong fixation points.
Manufacturing quality	The woven base as well as the coating must be homogeneous. The black fibres must be straight in wrap and weft and must cover the entire surface of the tarpaulin.
Recycled PE definition	As described by the Circular Plastic Alliance of the EU commission in EN 45557 and the US Federal Trade Commission Green Guides in accordance with ISO14021 principles, recycled plastic includes post-industrial and post-consumer recycled waste, it excludes reworked material. In this last case, even though it is encouraged to re-use scrap from tarpaulins production, it will not be counted as material from recycled origin.
Strength at state of origin and after UV exposure	
Test pieces for tensile and tear tests.	Cut all test pieces parallel to the direction of the fibres, in warp and in weft. The fibres should run from one end to the other end of each test piece.
Tear strength at state of origin	Minimum 200N under ISO 4674-1B 2003, with a test piece of 200x200mm as described in ISO 4674 annex B.
Tensile strength at state of origin	Minimum 750N and 15% to 35% elongation in warp and weft under ISO 1421-1.
UV resistance ASTM G53 ISO 1421-1	Apply 1500 hours UV under ASTM G53/94 (UVB 313 nm peak). Maximum 5% loss of strength compared to the original tensile strength of the actual product.
Cut resistance EN 388-6.2	Minimum index 2.5 Test 2 test pieces from one sample.
Tensile strength in the fixation points	Minimum 900N when pulling inside the fixation points as per ISO 1421-1, pulling perpendicular to the tarpaulin edge with a hook of 8mm wire diameter. Test 3 pieces of 200mm wide by 500mm long from each side of the tarpaulin.
Welding and strength at state of origin	Only one welding allowed, in the middle of the sheet, lengthwise. The tarpaulin tensile strength crosswise at the place of the welding under ISO 1421-1 must be minimum 50% of the original value of the actual product.
Size, weight, colour, opacity, fire resistance	
Width	4 m ± 1% net width
Length	5m minimum net length

Specific weight of the tarpaulin plain sheet.	170g/m² ± 10g under ISO 3801 (equivalent to 160g/m² minimum to 180g/m² maximum)
Weight of the complete tarpaulin	Total weight of the 20m² tarpaulin: 3.590kg min to 4.020kg max
Flame retardant EN13823+A1	Minimum class D, s2, d2. Minimum time to reach large wing external edge: 4minutes (LFS)
Flame retardant CPAI84	Pass CPAI84 sections 6 with maximum 10s after flame average and maximum 30s after flame per test piece. Ageing under ISO 4892-2, type A, 360 hours.
Colour ISO 105J01	Inner black fibres to ensure opacity. White coating on both sides of the sheet as per: L.a.b Coordinates: minimum "L": 82 "a" value between -1.7 and +1.5 "b" value between -4.5 and 0
Opacity measured as minimum reflection and maximum transmission, in the range of visible light and near infrareds. ISO 13168-1	Values should be measured respectively from 350 to 750nm, and from 750 to 2500nm wavelength. The result is the average of the averages in each range. Minimum total reflection: 35% Maximum total reflexion: 55% Maximum total transmission: 5% Absorption: remaining balance to reach 100%
Marking, packing	
Printing 1	Long lasting indelible printing in black colour of the manufacturer name, the month and year of production (Letters of 2.5cm high +/10%) printed on the sheet. Customer logo on request.
Printing 2	Long lasting indelible printing in black and grey colours of the recycling signs for LDPE and HDPE, of the user's guide, and of the "do not burn" sign.
Bale dimensions	Length: 560mm; Width: 390mm; Height: 200mm approximately There must be 5 tarpaulins per bale
Bale marking	As per indicated in contract.
Bale protection	The bale must be wrapped with a piece of the same tarpaulin material. The wrapping must be properly folded, closely tight to the bale content, making a well-shaped cubic bale. The tarpaulins are not individually wrapped.
Bale strapping	The bale must be strapped with 2 heat-sealed plastic straps for the length and 2 for the cross.



Drawing is not to scale

5.8 Other concerns

Topics related to technical specification that were not handled during the project:

- V-O-C. Volatile organic compounds. Are there any harmful VOC produced by the tarpaulin during usage that may affect the users?
- Usage for food contact. Are the tarpaulins safe for food contact?
- Can adhesive tapes be supplied for fixing damages, or preventing damages with reinforcing spots where the tarpaulin might rub on the frame components?

5.9 Communication

Publication of the new specification and AQL on the ICRC/IFRC Standard Products Catalogue

A final newsletter will be sent to all stakeholders and peer-reviewers<

A video to promote the outcomes of this R&D will be available in January 2024

6 PROJECT PLAN

6.1 Next steps

The Research Project is ending on December 31st, 2023 with the release of the new specification for the eco-designed tarpaulin.

Those new specification are now handed over to operations and procurement for implementation.

Technical support will be available to all manufacturers at: paoger@icrc.org

A follow up of the tarpaulins distributed during the field tests would be a first step to verify the appropriateness of the new specification on the long term.

Improve the quality assurance for every order and every production batch:

During the project, it was identified as a challenge for the procurement services to perform sufficient and efficient quality control. The quality of the distributed tarpaulins must be guaranteed by a strong and reliable quality management system. This is key to make a real impact by using the new eco-design tarpaulin.

7 ANNEXES

7.1 “recycle” logo

Both LDPE and HDPE logo to be printed on the tarpaulin. Size to be determined further.

7.2 “do not burn” logo

The below “do not burn” logo to be printed on the tarpaulin. Final design and size to be determined further.

7.3 “user’s guide” print

The below user’s guide to be printed on the tarpaulin. Final design and size to be determined further.