

'EXPRESSION OF INTEREST '

CRPF is in process to purchase Polycarbonate Shield.

2. The revised QRs/Specification and Trial Directives of said item is attached herewith.
3. The firms/parties dealing in subject matter are invited to submit their views by 20/07/2017.

Contract Person:-

RAJEEV KUMAR THAKUR
DY. INSPECTOR GENERAL OF POLICE (Provisioning)
DTE. GENL., CRPF,
LODHI ROAD, NEW DELHI
PH: 011- 24360155
FAX: 24360155
EMAIL: digprov@crpf.gov.in

REVIEW OF QRs/SPECIFICATION & QUALITATIVE REQUIREMENT OF POLYCARBONATE SHIELD

Sl. No.	Nomenclature	QRs/ Specifications approved by MHA vide letter No.L.VII-54/2010-12-Prov-R dated 13/11/2013	Revised QRs/ Specification proposed by Sub Group members of CAPFs and Scientists
A	B	C	D
1	Polycarbonate Shield	<ul style="list-style-type: none"> • Raw Material : Engineering grade Polycarbonate or any other technically proven superior material. • Provides excellent protection against brick batting, stone pelting, Molotov cocktails, chains, acids, iron, rod/cane attack. • Light weight, Scratch proof, durable and transparent. • Improved consistency in thickness and enhanced strength. • Thick ribs all along the edges for higher structural strength. • Vision area of shield so shaped as to avoid scratches during handling. • Cushioned/ comfortable arm rest for comfort and longevity. • High impact resistance. 	<p align="center">1. <u>SCOPE/ INTRODUCTION</u></p> <p>Polycarbonate shield is the most important protective equipment for a person deployed for handling riotous situation. It is required to protect him/ her when facing crowds during demonstrations/ processions and while dealing with riotous mobs. Polycarbonate shield has to protect the whole body from injuries due to impact, blow from blunt objects, brick batting, lathi blow, stone pelting, projectile/missiles, acid bulbs, Molotov cocktails and industrial chemical. A high standard Protective shield is therefore required for a policeman.</p> <p>Polycarbonate shield for riot police has to be light weight with shock absorption capabilities, good quality material and fire resistant for handling crowds with varying degree of hostility.</p>

A	B	C	D								
		<p><u>TECHNICAL DATA:</u></p> <ul style="list-style-type: none"> • Shape : Rectangular or any other proven better shape. • Length : 910 mm to 1000 mm • Weight : Less than 3.4 Kg. • Breadth(Flat) : 580mm \pm 20mm or any other proven better shape. • Breadth Concave : 620mm \pm 10mm or any other proven better shape. • Thickness : 3.00mm \pm 0.5mm • Material : Transparent/ scratch proof. • PC (Polycarbonate) virgin grade, and not recycled. • Edges well secured and covered by durable band/ elbows. • Raw material : Engineering grade Polycarbonate. • Provide complete protection against brick batting, stone pelting, iron rod/cane Attack, Molotov cocktails, acids. • Thick ribs all along the edges for higher structural strength. • Cushioned arm rest to provide comfort in long use i.e. to have solid strap, handle and pad for better grip. • High impact resistance. 	<p>Considering above aspects, QRs of a Polycarbonate shield are proposed as under;</p> <p><u>QRs/Specifications (Technical Data)</u></p> <p>2.1 Nomenclature: Polycarbonate Shield</p> <p>2.2 Colour : Colourless (More than 83% transparent)</p> <p>2.3 Weight : 3.4 Kg maximum. The weight of Polycarbonate body of the Shield shall be 2.6 Kg minimum.</p> <p>2.4 Dimensions :</p> <table border="1" data-bbox="1261 671 2040 826"> <tbody> <tr> <td>Length</td> <td>955 mm + 45 mm and – 20 mm</td> </tr> <tr> <td>Breadth (Flat)</td> <td>580 mm + 20 mm</td> </tr> <tr> <td>Breadth (Concave)</td> <td>620 mm \pm 10 mm</td> </tr> <tr> <td>Thickness</td> <td>03 mm Minimum</td> </tr> </tbody> </table> <p>2.5. Shape: Rectangular or any shape giving maximum coverage to the user.</p>	Length	955 mm + 45 mm and – 20 mm	Breadth (Flat)	580 mm + 20 mm	Breadth (Concave)	620 mm \pm 10 mm	Thickness	03 mm Minimum
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A	B	C	D																
			<p>3. <u>Material:-</u></p> <p>3.1. The polycarbonate sheet shall be made of high impact resistant/ natural polycarbonate material. It may contain additives, processing aids and stabilizers (for example UV absorbers).</p> <p>3.2. The polycarbonate material shall comply with the requirements given in Table 1 when tested as prescribed in Col-4 of Table 1.</p> <p>Table 1 Requirements for Polycarbonate Material :</p> <table border="1"> <thead> <tr> <th data-bbox="1256 560 1339 671">Sl. No.</th> <th data-bbox="1339 560 1765 671">Characteristics</th> <th data-bbox="1765 560 1995 671">Requirement</th> <th data-bbox="1995 560 2152 671">Method of test, Ref to IS/ Annx.</th> </tr> <tr> <th data-bbox="1256 671 1339 711">(1)</th> <th data-bbox="1339 671 1765 711">(2)</th> <th data-bbox="1765 671 1995 711">(3)</th> <th data-bbox="1995 671 2152 711">(4)</th> </tr> </thead> <tbody> <tr> <td data-bbox="1256 711 1339 951">i)</td> <td data-bbox="1339 711 1765 951">Melt Flow Index, g/10 min. (at 300°C under 1.2 Kg load when measured after pre-drying of the material at 120 ± 5°C upto 4 hrs.)</td> <td data-bbox="1765 711 1995 951">i) 1.5 to 8 (for extrusion/ Thermoforming) ii) 8 to 15 (for injection moulding)</td> <td data-bbox="1995 711 2152 951">IS 13360 (Part 4 / Sec 1)</td> </tr> <tr> <td data-bbox="1256 951 1339 1062">ii)</td> <td data-bbox="1339 951 1765 1062">Specific Gravity</td> <td data-bbox="1765 951 1995 1062">1.19 to 1.22</td> <td data-bbox="1995 951 2152 1062">IS 13360 (Part 3 Section 1)</td> </tr> </tbody> </table>	Sl. No.	Characteristics	Requirement	Method of test, Ref to IS/ Annx.	(1)	(2)	(3)	(4)	i)	Melt Flow Index, g/10 min. (at 300°C under 1.2 Kg load when measured after pre-drying of the material at 120 ± 5°C upto 4 hrs.)	i) 1.5 to 8 (for extrusion/ Thermoforming) ii) 8 to 15 (for injection moulding)	IS 13360 (Part 4 / Sec 1)	ii)	Specific Gravity	1.19 to 1.22	IS 13360 (Part 3 Section 1)
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A	B	C	D			
			iii)	Flexural Modulus, Min, MPa (with crosshead speed of 1.2 mm/min and a span to depth ratio of 16 to 1 (test specimen size, 04 mm x 10 mm))	2200	IS 13360 (Part-5 Section-7)
			iv)	Izod Impact Strength, notched, Min, kJ/m ² (test specimen thickness of 03 mm and notch radius of 0.25 mm)	60	IS 13360 (Part-5 Section-4)
			v)	Deflection Temperature under load at 1.82 MPa, Min, °C	120	IS 13360 (Part-6 Section-17)
			3.3. The polycarbonate body of the shield shall also comply with the requirements given in Table 2 when tested as prescribed in Col. - 4 of the Table 2.			
			Table 2 Requirements for Polycarbonate body of the Shield :			
			Sl. No	Characteristics	Requirement	Method of test, Ref to IS/Annex
			1	2	3	4
			i)	Dart drop Impact, Min, J (at 27°C)	150	Annx B of IS 14443
			ii)	Light Transmission, percent, Min	83	IS 13360 (Part-9 Section-5)
			iii)	Flammability Test (test specimen thickness 3.18 mm ± 0.13 mm)	94 HB class	IS 13360 Part-6 Section- 5

A	B	C	D
			<p>3.4 Ribs shall be given all along the edges for higher structural strength.</p> <p>3.5 The Polycarbonate body of the Shield shall have abrasion resistance surface coating on both surfaces.</p>
			<p>4. <u>Arm rest/ Handle:</u></p> <p>4.1 Cushioned arm rest to provide comfort in long use.</p> <p>4.2 Grips and supports must allow the user to comfortably hold and position the Polycarbonate Protective Shield.</p> <p>4.3 General requirement of handle :</p> <ul style="list-style-type: none"> a) Manufacturing process for handle should be Gas-Assisted injection Moulding (GAIM); b) Material for handle should be polymeric, preferably polycarbonate; c) Elastomeric bushes and washer system should be used for nut and bolt system. d) Metallic bolts, if used, shall be SS304 hex-headed M6 bolts; Nut and bolts system should preferably be self-locking.

A	B	C	D
			<p><u>Performance requirements of PC Shield</u></p> <p>5.1. Resistance to vandalism :</p> <p>5.1.1 The test is to provide complete protection against brick batting, stone pelting, iron rod/ cane attack.</p> <p>5.1.2 The Polycarbonate body of the shield shall have impact resistance of level 'A3' when tested for vandal resistance as per the test method prescribed in Annex C of IS 14443.</p> <p>5.2. Resistance to Force Entry: The Polycarbonate body of the shield shall have resistance of level 'B3' against penetration when tested for resistance to forced entry as per the test method prescribed in Annex D of IS 14443.</p> <p>5.3 Resistance to Surface Abrasion: The resistance of Polycarbonate shield to surface abrasion shall be tested in accordance with ASTM D 1044 for 100 cycles under 500 g load. Haze of test specimen shall not be more than 20 percent.</p> <p>5.4 Resistance to Environmental Stress Cracking: Environment Stress Cracking Resistance (ESCR) test shall be performed on polycarbonate body of the shield (with protective coating) by constant strain method as per IS 13360 (Part 8/ Sec 9).</p>

A	B	C	D
			<p>6. Life: 06 Years.</p>
			<p>7. <u>Miscellaneous:</u></p> <p>7.1. The word RAF/ POLICE in 110 mm width and 400 mm length may be written of fluorescent paper (color to be specified by user) in the middle of the front side or as required by user department.</p> <p>7.2. The design of the shield should be such that during handling the vision area should not fall on the resting surface.</p>
			<p>8. Certification :</p> <p>Various tests shown above are done at following laboratories:</p> <ul style="list-style-type: none"> i) CIPET Labs. ii) DIPAS/ DRDO New Delhi iii) NITRA, Ghaziabad iv) ATIRA, Ahmedabad v) GFSU, Gujarat vi) CFSL Labs vii) Any other NABL approved laboratory having scope of above parameters.

TRIAL DIRECTIVE OF POLYCARBONATE SHIELD

Sl. No	QRs/ Specifications approved by MHA vide letter No.L.VII.54/10-12- Prov-R dated 13/11/2013	Revised TDs proposed by Sub Group members of CAPFs and Scientists								
1	<p data-bbox="331 402 591 435">A. <u>P.C. SHIELD:-</u></p> <p data-bbox="282 475 1128 509">TRIAL WILL BE CONDUCTED ON THE FOLLOWING TEST</p> <p data-bbox="331 549 1258 619">01. <u>PHYSICAL TEST:-</u>The Dimension will be measured physically as per tender enquiry and mentioned in the following table.</p> <table border="1" data-bbox="282 655 857 810"> <tbody> <tr> <td data-bbox="282 655 568 694">Length</td> <td data-bbox="568 655 857 694"></td> </tr> <tr> <td data-bbox="282 694 568 732">Breadth</td> <td data-bbox="568 694 857 732"></td> </tr> <tr> <td data-bbox="282 732 568 770">Thickness</td> <td data-bbox="568 732 857 770"></td> </tr> <tr> <td data-bbox="282 770 568 810">Weight</td> <td data-bbox="568 770 857 810"></td> </tr> </tbody> </table>	Length		Breadth		Thickness		Weight		<p data-bbox="1330 402 1805 435">I. <u>TRIAL METHODOLOGY</u></p> <p data-bbox="1281 475 2150 948">The purpose of the Polycarbonate shield is to protect the policeman from the various types of missiles that are thrown at him by the rioters. Such missiles range from stones or similar pieces of bricks/concrete, pieces of glass and glass bottles, acid bulbs/ bottles containing sulphuric acid used in storage batteries and hydrochloric acid used for toilet cleaning purposes and burning rags/bicycle tires and Molotov cocktails/firebombs made basically by petrol diesel/kerosene. The rioters may also attack the policeman with various types of wooden bamboo sticks and bicycle chains that would not be thrown but would be wielded by hands on coming close to the policemen. Therefore, the Polycarbonate shield must be able to provide adequate whole body protection from all above threats.</p> <p data-bbox="1281 954 2150 1019">In such circumstance, high standard of Polycarbonate shield is required for protection of policeman.</p>
Length										
Breadth										
Thickness										
Weight										

02. RESISTANCE TO IMPACT TEST:-**Trial Philosophy:-**

The purpose of the polycarbonate shield is to protect the policeman from the various types of missiles that are thrown at him by the rioters most commonly. such missiles range from stones or similar pieces of bricks/concrete; pieces of glass and glass bottles, acid bulbs/bottles containing sulphuric acid used in storage batteries and hydrochloric acid used for toilet cleaning purposes; and burning rags/bicycle types and Molotov cocktails/firebombs made basically by petrol/diesel/kerosene. The rioters may also attack the policeman with various types of wooden/bamboo sticks and bicycle chains that would not be thrown but would be wielded by hands on coming close to the policeman. The shield is the only defensive implement available to the policeman and hence it must be able to provide him adequate protection from all such threats. The second issue is that the USP (unique selling proposition) of the polycarbonate shield over the old wicker shield was that it is transparent which allows the user to constantly see what is in front of him as he tries to protect himself whereas the old wicker shield seriously hampered visibility. When our men are facing a barrage of stones, the shield necessarily needs to be transparent so that he may see the stone coming through it and man oeuvre himself properly or wield the shield suitably so as to block the stone. So is the case with a stick. A wicker (cane) shield severely restricts visibility and thus becomes a handicap in facing a barrage of stones or sticks. Hence the polycarbonate shield must retain its transparency even after a certain amount of bombardment by the missiles discussed above. It should not develop such scratches or cracks that would reduce its visibility to an unacceptable level.

02. Physical test:

- a) The dimension will be measured physically as per QRs by board of officers:

2.1 Nomenclature : Polycarbonate Shield

2.2 Colour : Colourless (More than 83% transparent)

2.3 Weight : 3.4 Kg maximum. The weight of Polycarbonate body of the shield shall be 2.6 Kg minimum.

2.4 Dimensions :

Length	955 mm + 45 mm and - 20 mm
Breadth (Flat)	580 mm ± 20 mm
Breadth (Concave)	620 mm ± 10 mm
Thickness	03 mm Minimum

2.5 Shape: Rectangular or any shape giving maximum coverage to the user.

The PC Shield is not supposed to protect the policeman from a rioter who has got iron rods, GI pipes, heavy metal chains (such as those of bikes), 03 heavy sticks (such as oars or iron-bound lathis), nunchakus and sharp-edged metallic weapons like swords and hence it will not be tested against them. It should be kept in mind that flexible weapons like chains and nunchalus, even if they are stopped by the shield, can still flex their way around and hurt the policeman.

Trial Methodology

The only way of testing the P.C. Shield is to test it against the types of missiles that have been described above. The scientific way of testing is to prescribe the exact nature of the missiles that would be used in testing. This is necessary because they come in a huge variety and a shield that would protect against all of them would become unacceptably heavy. The choice is dictated by prevalence of use that is, the board has chosen those missiles which are most widely used and hence most likely to be encountered by the policeman.

Stones-Pieces of bricks/concrete:

In real life, people throw stones that vary from 100 gm to 500 gm. For the purpose of this directive, the board has actually weighed pieces of stones and compared them with the pieces that we have collected from those that the unlawful assemblies/rioting have thrown at us at various places in the country. There are photographs available in which they have been found throwing stones that could be as heavy as 8-10 kg. But such stones are usually thrown against vehicles and we may ignore them for personnel. The board finds that pieces weighing about 150 gm are eminently suited by

03. Material:-

Labs will conduct following test for testing the material of Polycarbonate sheet:-

3.1 Polycarbonate Sheet Material test:

- a) Melt flow Index – As per IS 13360 (part 4/Sec 7).
- b) Specific Gravity – As per IS 13360 (Part 3/Sec 1).
- c) Flexural Modulus – As per IS 13360 (Part-5 Section-7).
- d) Izod Impact strength - As per IS 13360 (Part-5 Section-4).
- e) Deflection Temperature – As per IS 13360 (Part-6 section-17).

3.2 Polycarbonate Shield material test:

- a) Dart drop Impact - As per IS 14443 Annex B.
- b) Light Transmission -- As per IS 13360 (Part-9, section-5).
- c) Flammability -- As per IS 13360 (Part 6/ Sec 5)

their size to be thrown with maximum speed. A piece of stone weighing 150 gm is typically less than 6 cm x 4.5 cm x 3.5 cm in size. It fits in the hand so well that it lends itself excellently to be thrown with maximum speed. The rioters, of course, throw bigger as well as smaller pieces also. We will ignore them in the test. But we will use pieces of bricks and concrete of 150 grams.

The next question that arises is the speed with which the stones are thrown. Ideally a speed radar must measure speeds but that may be impractical in our circumstances as it would not be easily available to us. However, there are simple ways of estimating speeds with sufficient accuracy. More important for us is to simulate real life conditions. The simplest method for this purpose is range. The board has observed in numerous riotous situations that the rioters are able to throw such stones at up to 75 yards range. But 45 yards range is more common. Stones of 150 grams would therefore be thrown by our men (since all of them uniformly possess a prescribed minimum bodily strength and fitness as determined from various standard test at 45 yards with two hopping steps run up because the rioters are also seen using this technique most frequently).

Pieces of glass/glass bottles:

The weight of the pieces of glass/glass bottles would also be limited to 150 grams. They will be made by bare hands may be risky, the throwers can use leather gloves.

Testing Parameters

The shield would be fitted in a heavy bracket that would simulate its being held in a human hand and then missiles would be thrown on it. In other words the shield shall be held from its grip and not fitted in a frame from its sides. The structure supporting the device that holds the shield shall be sufficiently heavy (70 kg to simulate a man's body weight) so that the

4. Arms rest/Handle:

Fitments of Arms rest and handle to be physically checked by Board of Officers as per QRs.

5. Performance test:

5.1. Resistance to vandalism :

The Polycarbonate body of the shield shall have impact resistance of level 'A3' when tested for vandal resistance as per the test method prescribed in Annex- C of IS 14443.

5.2. Resistance to Force entry:

The polycarbonate body of the shield shall have resistance of level 'B3' against penetration when tested for resistance to forced entry as per the test method prescribed in Annex D of IS 14443.

5.3 Resistance to Surface Abrasion:

The body of the shield when tested for resistance to surface abrasion in accordance with ASTM D1044 for 100 cycles under 500 g load, shall have haze percent not more than 20 percent.

impact of the missiles is absorbed largely by the shield and not transferred to the frame. A real man cannot be allowed to hold the shield because in case the device fails or if the thrower misses his mark, the man could be injured. Our men would stand 45 yards from it and throw missiles on it. In real life, it has been seen that sometimes the rioters come as close as 25 yards. It is necessary to ensure that the shield does not break from this range also. Each shield shall be subjected to 25 direct (and not bounced) hits each by missiles of the type described above at the two ranges-45 and 25 yards. The shield must not shatter or develop cracks under the individual or cumulative impact of such missiles. It should also not get scratched in such a manner as to reduce its visibility. The entire experiment shall be video recorded and still photographs shall also be taken of the shield before and after the use of the missiles.

When corrosive substances like acids and burning rags are used against the shield, the shield should not get damaged by them.

Acid bulbs/bottles:

Since it is potentially dangerous for throwers to use acid bulbs (the rioters are desperados in comparison) the acid resistance of the P C shield shall be determined by pouring the acids of the type described above on the shield and observing the outcome. Time of contact will be 30 minutes because in real life, a policeman who gets attacked by these may not get time up to 30 minutes to withdraw from the scene and clean the shield

Burning Rags/Bicycle Tires/Molotov Cocktails/Firebombs:

Burning rags are thrown by rioters attached on a stick. Burning bicycle tyres or pieces thereof are thrown solo. A Molotov cocktail or firebomb is a glass bottle with a combustible fluid such as petrol/diesel/kerosene filled inside to some capacity and the rest filled with rags which are lighted and

5.4 Resistance to Environmental Stress Cracking:

Environment Stress Cracking Resistance (ESCR) test shall be performed on polycarbonate body of the shield (with protective coating) by constant strain method as per IS 13360 (Part 8/Sec 9).

thrown. In India we have so far not encountered the use of gelled fuel and hence we shall not be testing for that. In any case, the purpose is to check fire resistance. The resistance to a bottle or its piece has already been covered above. Hence, the shield need only to be exposed to the fire of burning rags soaked in petrol/diesel/kerosene and burning bicycle types. Since in real life the policeman is supposed to fend it off as possible, the time of contact will be limited to 10 seconds.

Sticks:

Sticks come in a wide variety of sizes. Obviously the shield cannot be expected to protect from all of them. The board, after a study of the sticks used in various riots and also in martial arts has found that a bamboo stick 32 inches long and of one inch diameter typically weighs less than 375 gm. This is a stick that can be easily wielded with one hand. In practice therefore, it can be inferred from this that we should seek protection from bamboo sticks that weigh 500 gm and can be wielded with both hands.

Testing Parameters:

The man will stand in front of the shield in the bracket and hit it with full force with the stick wielded by both hands. The shield will be hit 25 times. It should not develop any crack at all anywhere on its body.

3. Certification test- any NABL (national accreditation board for testing and calibration laboratories) approved laboratories tests or certificates regarding quality of the standard of materials used and technical parameters may be verified during product delivery as per practice in vogue.

6. Certification:

Various tests shown above are done at following laboratories.

- i) CIPET Labs.
- ii) DIPAS/ DRDO, New Delhi
- iii) NITRA, Ghaziabad
- iv) ATIRA, Ahmedabad
- v) GFSU, Gujarat
- vi) CFSL Labs
- vii) Any other NABL approved laboratory having scope of above parameters.