Motorcycle Protective Clothing –Outcomes from a Pilot Testing Program

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ABSTRACT

Motorcyclists are amongst the most vulnerable road users, with riders 38 times more likely than car drivers to be seriously injured on the roads. One of the most effective ways for riders to reduce their risk of injury is to wear appropriate protective gear. Currently in Australia, helmets are the only protective equipment which riders are required by law to wear. Australian/New Zealand Standard AS 1698 provides a minimum standard for the protective qualities of helmets, but no such standard applies to other protective garments for motorcycling. In the absence of information on the quality of protective gear, many riders are basing their decisions on cost, branding and retailer advice, none of which provide an independent indicator of the protective quality of the garment. In this regard, an independent protective clothing testing program may have an important role to play. The Transport Accident Commission (TAC) in partnership with VicRoads is currently investigating the feasibility of setting up a motorcycle protective clothing testing program and the potential dissemination of such results to the public. This paper will discuss some of the preliminary findings from the setting up of the pilot program and the initial testing of protective gear.

Key words: motorcycles; protective clothing; consumer information; testing program

1. Introduction

In Victoria, motorcyclists represent less than 4% of the number of registered vehicles and account for approximately 1% of vehicles kilometres travelled (Transport Accident Commission [TAC], 2012). Approximately 8% of Victorian licence holders have a motorcycle licence and in 2011, motorcyclists represented 17% of the road toll (TAC, 2012).

There are a number of ways riders can reduce their risk of injury on the road and one of the most effective ways is to wear appropriate protective gear. Research has pointed to the effectiveness of protective clothing in decreasing the risk of open wound injuries (McIntyre, Nieuwesteeg, & Cockfield, 2011) and the rate of hospital admissions (de Rome, Ivers, Fitzharris, Du, Haworth, Heritier, & Richardson, 2011). The Transport Accident Commission (TAC) has been promoting the importance of wearing protective clothing to riders for over five years. To improve understanding about the importance of wearing protective clothing at all times, the TAC has developed a number of public education campaigns on protective clothing. Television, radio, print media campaigns, promotion of the message at events such as the MotoGP and the Motorcycle Expo, as well as provision of materials to assist retailers sell protective clothing have all been undertaken with the aim of increasing the wearing rate of protective clothing. In response to the promotion of protective clothing, riders frequently ask what type of protective clothing they should purchase and how can they differentiate between the protective quality of different garments. Riders have expressed that they are interested in obtaining more information to help them make informed choices, with research indicating that an overwhelming majority of riders believe that they would find it useful to have a star rating system to signal how well protective clothing could protect a rider in the event of a crash (Kerryn Alexander Research, 2007). In the absence of mandated standards, an independent protective clothing testing program may have an important role to play.

2. Pilot testing program

The TAC and VicRoads were interested in developing a program that can provide riders with sufficient independent information to make the best selection possible with regard to purchasing and wearing protective clothing. Some work has already been undertaken in this area by VicRoads and the Motor Accidents Authority of NSW (MAA) into how to improve consumer information about protective clothing (deRome, Gibson, Haworth, Ivers, Sakashita, & Varnsverry, 2012), the potential of a star rating system in disseminating the results to consumers (Haworth, de Rome, & Rowden, 2006; Kerryn Alexander Research, 2007) and the feasibility of a star rating system (HDG Consulting Group, 2008).

Taking the research one step further, the TAC and VicRoads began investigating the feasibility of setting up a motorcycle protective clothing testing program and the dissemination of the test results to the public. The aims of the pilot program were to provide information to the agencies around the feasibility (practicality and cost implications) of conducting a motorcycle protective clothing consumer program and to determine what information could be provided to consumers and in what format.

Australian road safety agencies have much experience in the development of consumer information programs such as Australasian New Car Assessment Program (ANCAP), Used Car Safety Rating (UCSR) Child Restraint Evaluation Program (CREP) and Consumer Rating and Assessment of Safety Helmets (CRASH). These programs have provided road safety agencies with an in-depth understanding of key areas to be addressed including; testing procedures, protocols development and how information is disseminated to consumers. In setting up the motorcycle protective clothing pilot program, one of the first steps was to establish a representative reference group to help guide the project.

2.1 Reference Group and Technical Consultant

The TAC and VicRoads established a reference group with key representatives from the motorcycling industry to assist in the project and to provide advice on the potential dissemination of any test results. Representatives invited to join the reference group included:

- Local manufacturers – some with experience in undertaking testing of their own products
- Importers of motorcycle garments and retailers – to provide advice on garment selection for testing and the seasonal rate of turnover
- Industry representatives

In addition to the reference group, the agencies also engaged a technical consultant with expertise in the testing of protective clothing to assist in designing the testing protocol and the interpreting of the results.

2.2 Selection of Test Protocol

Currently in Australia, helmets are the only protective equipment that need to comply with an Australian/New Zealand standard and which riders are required by law to wear. However, there are no Australian equivalent standards for motorcyclists' protective clothing and thus many riders are basing their protective gear decisions on cost, branding and retailer advice (Kerryn Alexander Research, 2007), none of which provide an independent indicator of the protective quality of the garment.

There are a number of testing regimens for motorcycle protective clothing but the most comprehensive testing scheme available is that provided under the European (EU) Standards (de Rome et al., 2012). The EU Standards for protective clothing was originally designed for protective suits on the racetrack but later became applicable for all motorcycle clothing (de Rome et al., 2012). As the EU Standards for motorcycle garments were the most comprehensive standards available, the protocol for the testing of motorcycle garments under the EU Standards was adopted for the pilot program.

2.3 European (EU) Standards

The EU Standard is primarily concerned with the protection provided by clothing against injury in crashes. Clothing which claims to provide protection from injury must be independently tested and approved in accordance with the requirements of the European Standards for Personal Protective Equipment (PPE) Directive. Products which comply with the directive will display the 'Conformité Européen' (CE) mark and the associated standards number.

Standards currently exist for:

- motorcycle jackets and trousers (EN 13595)
- gloves (EN 13594)
- boots (EN 13634)
- impact protectors (EN 1621-1)
- back protectors (EN 1621-2)

In Australia, garments are available that incorporate protectors covered by EN 1621-1 & 2. These are inserts within a garment that provide improved protection for vulnerable body parts such as the spine, knee, shoulder or elbow. Far less common are garments that comply with a 'whole of garment' standard such as EN 13595 (jackets and pants).

The initial testing of the pilot program focussed solely on testing motorcycle jackets and pants to the requirements of EN 13595.

2.4 Selection of Garments for Testing

In deciding what type of motorcycle garment should be selected for testing, a number of factors were taken into consideration. These included:

- **Injury rates** – an analysis of injuries received by TAC clients (McIntyre, Nieuwesteeg & Cockfield, 2011) found that legs and the upper body/arms were amongst the most likely parts of the body to be injured in a motorcycle crash, with 62% and approximately 50% of all injured riders having sustained lower limb and upper limb/trunk injuries, respectively.

- **Wearing rates** – research indicates that riders are least likely to wear protective pants and jackets and most likely to wear helmets and gloves (Kerryn Alexander Research, 2007; McIntyre, Nieuwesteeg & Cockfield, 2011; Wishart & Watson, 2011; Wishart, Wilson, & Watson, 2010)

- **What information do riders want?** – anecdotal evidence from talking to riders at events such as the MotoGP suggests that providing safety information on jackets and pants would be most valuable to them.

Based on the above considerations, it was decided that the initial testing of the pilot program would focus on motorcycle jackets and pants. Eight separate pieces of garments (one jacket and one pants from each of four manufacturers) were selected for testing. The garments selected represented a range of price points, were from

different manufacturers and were constructed from either leather or textile. These garments were sent to the test laboratory to begin the testing process.

2.5 Selection of a Test Laboratory

There are a limited number of test laboratories available around the world that can undertake the testing for motorcycle garments as required under the EU Standards. None of these test laboratories are in Australia. In consultation with the technical consultant, it was decided that SATRA located in the UK would be the most appropriate laboratory to undertake the testing for the pilot program. SATRA is one of the world's leading research and technology centres and a key laboratory in the testing of motorcycle garments to the EU Standards. SATRA is located close by to the technical consultant which allows for the consultant to observe the testing process and consult with SATRA in person on the agencies' behalf. As SATRA is located in an English speaking country, this ensured no language barriers between the laboratory and the agencies. SATRA was commissioned by the agencies to undertake the full suite of EN 13595 compliance tests.

2.6 EN13595 – Protective clothing for professional motorcyclists – Jackets, trousers and one piece or divided suits

The EU Standards are adopted by national jurisdictions as a national standard such as the British Standard. According to British Standard (2002), there are four parts to EN 13595:

Part 1 – General Requirements covers issues relating to the technical and zoning requirements of the garments. In the event of a crash, the risk of impact and abrasion varies across the garment. Areas that are at risk of extended contact with the road are expected to provide higher levels of protection. In testing, a garment is divided into four risk categories as follows:

Zone 1	Areas at high risk of impact
Zones 1 & 2	Areas at high risk of abrasion
Zone 3	Areas at moderate risk of abrasion
Zone 4	Areas at low risk of abrasion

Figure 1 demonstrates the different zones and the likely risks.

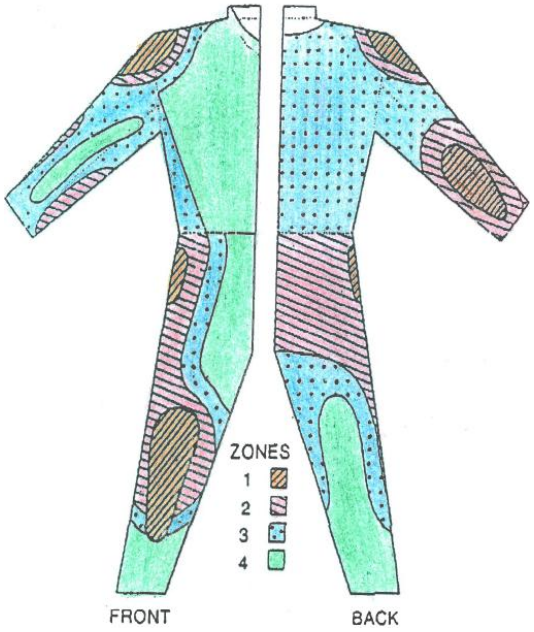

Fig 1: Risk categories by zones (adapted from British Standard, 2002)

The other three parts of the standards include:

- Part 2 - Test method for determination of impact abrasion resistance – six tests required per construction
- Part 3 -Test method for determination of burst strength – five tests required per seam
- Part 4 - Test method for determination of impact cut resistance – six tests required

The tests are measured according to the following two levels of protection:
Level 1 – Clothing designed to give some protection whilst having the lowest possible weight and ergonomic penalties associated with its use.

Level 2 – Clothing providing a moderate level of protection, higher than that provided by level one. There are however, weight and restriction penalties in providing this level of protection (British Standards, 2002).

2.7 Harvesting of Specimens

Manufacturers seeking to obtain CE certification for their garments would usually provide the test laboratory with sheet materials representative of each and every seam and construction found in the final garment. As there are only a limited number of manufacturers of motorcycle garments in Australia, with the majority residing overseas, engaging with overseas manufacturers to obtain samples would be difficult and testing products produced by local manufacturers would not be representative of the types of garments purchased by consumers. Therefore it was decided that the pilot program would test finished garments. This is in line with the practice of other consumer information programs such as ANCAP, where products available for sale to the public can be randomly selected for independent testing purposes.

The use of finished garments for testing posed an issue when attempting to harvest specimens for testing. Test specimens must be of a certain dimension and size according to the requirements of EN 13595. However, the design, cut and variety of materials and seams found in the finished garments meant that 'clean' specimens of the specified dimensions could not always be obtained. Another limitation was that the presence and overlap of multiple constructions in specimens harvested did not allow for testing of individual seams.

In discussing the issues encountered with the technical consultant and SATRA, the following three options were considered.

1. Attempt full EN 13595 testing – however, it was unlikely that every material and seam construction could be harvested, even if additional garments were supplied, due to the overlap in constructions and limited presence of some material types.

2. Indicative testing of materials and constructions for which test specimens can be harvested – this can provide indicative test data based on any materials and constructions that can be harvested according to the requirements. However, the risk is that main materials and constructions in key areas might not be tested due to harvesting issues.

3. Assessment of zonal placing of multiple materials and constructions – this involves testing of materials and seam constructions which can be harvested according to the requirements. Where multiple constructions exist, these would be harvested and tested together, with the result taken from the weakest construction which fails first.

Option 1 (attempt full EN 13595 testing) was the preferred option, however, it was unlikely that the required number of test specimens could be harvested for each construction and seam due the limited quantities available on the garments. Option 2 (attempt indicative testing) ran the risk of the results not being representative of the overall protective quality of the garment if materials and seams cannot be harvested to the specified requirements in key impact zones.

After consultation with the reference group, it was decided that option 3 was the most appropriate compromise for full EN 13595 and would be explored further. In real world crashes, stress and impact would be placed on the garment as a whole, which includes the interaction between different materials and seams. The final assembly of materials and seams in a finished garment might affect how each performs in a crash and introduce deficiencies not observed when they are tested individually. Therefore, option 3 would most closely replicate impacts and abrasions observed in real world crashes.

The technical consultant and SATRA were asked for advice on how many additional pieces of garments would be required if we were to proceed with option 3. After discussions, an additional 8 garments were sent to SATRA for testing.

3. Preliminary Results

The initial testing conducted thus far have only considered abrasion resistance and burst strength. Two sets of each test were conducted on samples harvested from each of the following areas: shoulder, elbow, back, front, knee and hip.

Tables 1 and 2 below set out the requirements which tested samples need to meet in order to fulfill the requirements of EN 13595. Each of the test results are compared to the requirements to determine if the individual tests pass or fail the requirement.

Table 1: EN 13595 Clause 5.4 Abrasion resistance requirements

Zones	**Abrasion Resistance Requirements/seconds**	
	Level 1	Level 2
1 & 2	4	7
3	1.8	2.5
4	1	1.5

Table 2: EN 13595 Clause 5.6 Burst strength requirements

Zone	**1 & 2**	**3**	**4**	**Linings**
Requirement/kPa Level 1	700	500	400	200
Requirement/kPa Level 2	800	600	450	200

The abrasion resistance and burst strength test results for each pants and the corresponding jacket from the same manufacturer are grouped together in the tables below. It is important to note that none of the garments tested claim to meet the requirements of EN 13595.

Table 3: Abrasion resistance & burst strength results for Manufacturer A – Jacket and Pants

EN 13595 Clause/Test	EN 13595 Requirements	Results			UoM*	Pass/Fail#
		Sample Area	Relative Abrasion Seconds			
5.4 Abrasion Resistance	Refer to Table 1	Shoulder	27.67^		±0.24s	FAIL
		Shoulder	23.74^			
		Elbow	6.39			
		Elbow	13.66			
		Back	8.32			
		Back	**1.11##**			
		Front	4.57			
		Front	9.69			
		Knee	20.01			
		Knee	16.40			
		Hip	26.95			
		Hip	30.55			
5.6 Burst Strength	Refer to Table 2	**Results**			±32kPa	FAIL
		Sample Area	**Burst Pressure kPa**	**Failure Type**		
		Shoulder	925	Thread		
		Shoulder	**695**	Thread		
		Elbow	>1000	N/A		
		Elbow	>1000	N/A		
		Back	>1000	N/A		
		Back	>1000	N/A		
		Front	>1000	N/A		
		Front	>1000	N/A		
		Knee	>1000	N/A		
		Knee	850	Fabric		
		Hip	800	Thread		
		Hip	**600**	Fabric		

*****Denotes Uncertainty of Measurement for stated test results and provides a confidence level of approximately 95%

Fail indicates if any individual results fall below the requirements of EN13595 but does not indicate if the garment as a whole would pass or fail the relevant clauses of this standard

^Protective shell within cover a large part of the shoulder region and this material was not tested

##Test carried out on the elasticated material at the side of the jacket on the back that fall within the zone 3 area of protection

Table 4: Abrasion resistance & burst strength results for Manufacturer B – Jacket and Pants

EN 13595 Clause/Test	EN 13595 Requirements	Results			UoM*	Pass/Fail #
		Sample Area	**Relative Abrasion Seconds**			
5.4 Abrasion Resistance	Refer to Table 1	Shoulder	4.40		±0.24s	PASS
		Shoulder	5.00			
		Elbow	35.38			
		Elbow	26.70			
		Back	11.69			
		Back	14.66			
		Front	4.97			
		Front	12.03			
		Knee	9.44			
		Knee	53.56			
		Hip	5.76			
		Hip	19.30			
5.6 Burst Strength	Refer to Table 2	**Results**			±32kPa	FAIL
		Sample Area	**Burst Pressure kPa**	**Failure Type**		
		Shoulder	**600**	Fabric		
		Shoulder	800	Fabric		
		Elbow	1000	N/A		
		Elbow	900	Thread		
		Back	800	Fabric		
		Back	550	Fabric		
		Front	1000	N/A		
		Front	575	Fabric		
		Knee	>1000	N/A		
		Knee	>1000	N/A		
		Hip	850	Fabric		
		Hip	600	Fabric		

*****Denotes Uncertainty of Measurement for stated test results and provides a confidence level of approximately 95%

Fail indicates if any individual results fall below the requirements of EN13595 but does not indicate if the garment as a whole would pass or fail the relevant clauses of this standard

Table 5: Abrasion resistance & burst strength results for Manufacturer C – Jacket and Pants

EN 13595 Clause/Test	EN 13595 Requirements	Results			UoM*	Pass/Fail #
		Sample Area	Relative Abrasion Seconds			
5.4 Abrasion Resistance	Refer to Table 1	Shoulder	13.06		±0.24s	FAIL
		Shoulder	17.11			
		Elbow	5.39			
		Elbow	5.66			
		Back	**1.21**			
		Back	**1.15**			
		Front	7.97			
		Front	9.05			
		Knee	**1.83**			
		Knee	**2.26**			
		Hip	8.55			
		Hip	6.85			
5.6 Burst Strength	Refer to Table 2	**Results**			±32kPa	FAIL
		Sample Area	**Burst Pressure kPa**	**Failure Type**		
		Shoulder	>1000	N/A		
		Shoulder	700	Thread		
		Elbow	900	Thread		
		Elbow	**600**	Thread		
		Back	>1000	N/A		
		Back	1000	Thread		
		Front	>1000	N/A		
		Front	750	Thread		
		Knee	**500**	Thread		
		Knee	700	Thread		
		Hip	900	Thread		
		Hip	650	N/A		

*****Denotes Uncertainty of Measurement for stated test results and provides a confidence level of approximately 95%

Fail indicates if any individual results fall below the requirements of EN13595 but does not indicate if the garment as a whole would pass or fail the relevant clauses of this standard

Table 6: Abrasion resistance & burst strength results for Manufacturer D – Jacket and Pants

EN 13595 Clause/Test	EN 13595 Requirements	Results		UoM*	Pass/Fail #
		Sample Area	**Relative Abrasion Seconds**		
5.4 Abrasion Resistance	Refer to Table 1	Shoulder	17.12	±0.24s	PASS
		Shoulder	24.27		
		Elbow	26.47		
		Elbow	13.93		
		Back	5.26		
		Back	10.61		
		Front	11.96		
		Front	12.15		
		Knee	18.32		
		Knee	14.13		
		Hip	6.57		
		Hip	6.54		

5.6 Burst Strength	Refer to Table 2	**Results**			±32kPa	FAIL
		Sample Area	**Burst Pressure kPa**	**Failure Type**		
		Shoulder	**600**	Fabric		
		Shoulder	>1000	N/A		
		Elbow	>1000	N/A		
		Elbow	800	Fabric		
		Back	600	Thread		
		Back	600	Thread		
		Front	575	Fabric		
		Front	>1000	N/A		
		Knee	>1000	N/A		
		Knee	1000	Fabric		
		Hip	700	Fabric		
		Hip	950	Thread		

*****Denotes Uncertainty of Measurement for stated test results and provides a confidence level of approximately 95%

Fail indicates if any individual results fall below the requirements of EN13595 but does not indicate if the garment as a whole would pass or fail the relevant clauses of this standard

4. Discussion

The aims of the motorcycle protective clothing pilot testing program were to provide information to the agencies around the feasibility (practical and cost) implications of conducting a motorcycle protective clothing consumer program and to determine what information could be provided to consumers and in what format. While some of the implications are yet to be determined, the initial testing process has raised a number of questions and considerations which would assist in moving the program forward.

4.1. Multiple constructions and seams

Some issues were encountered early on in the program regarding the harvesting of test specimens according to the requirements of EN 13595 due to finished garments being used for the testing process. While the solution of testing multiple seams and constructions appears reasonable, as these are the assemblies found in finished products being sold to consumers, further consideration will still need to be given to any potential pitfalls that may exist and are not yet evident. As this is a modification to the current testing requirement under the EU Standard, the credibility (real and perceived) of the revised methodology will be an important consideration.

4.2. Testing to the European Standards

The agencies understand that none of the garments claim to comply with EN 13595 and therefore would not be expected to pass the requirements. However, it is important to understand the full cost and practical implications associated with testing garments to, or as close to as possible, the EU Standard. With the EU Standard being the most comprehensive standard available in the world for motorcyclists' protective clothing, it is essential that the agencies fully explore the option of testing to the full requirements of EN13595, before making a decision on what testing in an ongoing program would entail. Indicative testing may provide good indication of the protective quality of the garments and it might be that full testing is not required. But until the full number of tests are conducted, there is no way to compare whether there is much difference between full and indicative testing and which option would provide the best information and cost-benefit.

The preliminary results from the pilot testing program so far can be considered indicative testing only (i.e. only a limited number of tests conducted) and the results indicated a fairly large variation for some test results from the same test areas. For example, for the garments from Manufacturer B (refer to Table 4), the two abrasion resistance test results for the knee areas were 9.44 seconds and 53.56 seconds. While both results pass the level 2 requirements of the abrasion resistance requirements, it does raise the questions of why there is such a large difference in the results and how can these results be translated. Under the EN 13595 requirements for abrasion resistance and burst strength, six and five specimens are required respectively per construction and seam present. In the testing program to date, only two specimens per area were harvested and tested. It may be that further testing as per EN 13595 is required to fully understand the test results.

4.3. Manufacturers

The preliminary results provide some valuable insight into the deficiencies of the garments. For example, the burst strength test results details whether it was the thread or fabric that was the weakest link. This type of information might prove useful to manufacturers. A future program may consider making the raw test results available to manufacturers to assist them in improving the safety standards of their products.

4.4. Overseas Laboratory

Currently, the testing of the garments for the pilot program is being conducted by SATRA located in the UK as there are equivalent test laboratories in Australia. Conducting the testing offshore in a rollout of the program has obvious cost and timing implications related to the freight of the garments. Until the complete complements of tests are conducted, the full cost and timing implications cannot be calculated. However, these will be important considerations for any ongoing consumer program in terms of how many garments can be tested and the long-term viability of the program and timely release of test results.

4.5. Next Steps

In moving forward, the agencies will arrange for additional garments, of the same brand and model, to be sent to SATRA. This will allow for the additional abrasion resistance and burst strength tests required under EN 13595 to be conducted. In

addition, other tests required under EN 13595 such as impact cut test, design, fit and ergonomics, restraint, fabric tear strength and chemical innocuousness will also be conducted for each of the garments. In conducting the full complement of tests as required under the EU Standards, the agencies will have a clearer understanding of the cost, timing and practical implications for any ongoing consumer program. Once the full results are available, consideration will be given to the potential translation of the results.

5. Conclusion

The initial phase of the pilot program has raised a number of important questions that have aided the team in their thinking on what a future program might entail. While there are still a number of hurdles to overcome before consideration can even be given to the potential translation of the results into a rating system, the pilot program is an important first step in the right direction in assisting riders to make more informed safety choices regarding protective clothing. Additional pieces of garments will be tested and once the full results are available, the TAC and VicRoads will consider how best to translate and disseminate the results to consumers.

Acknowledgments

The TAC and VicRoads wish to acknowledge the advice and expertise provided by the Pilot Program Reference Group members, Mr Paul Varnsverry and SATRA Technology Centre.

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