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# **Body Armour Good Practice and Quality Framework**

Publication No. 44/07

Cliff Dixon  
John Croft





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# 1 Introduction

In recent years there have been several tragic operational incidents which have resulted in officers and police staff being seriously injured and even fatally wounded whilst carrying out their duties. There have also been a number of concerns raised regarding the procurement, testing, quality assurance and ‘apparent’ failure of some body armour models.

Additionally, a change in the weapons and ammunition used by some forces has resulted in the potential for ballistic failure of armours that have been procured to protect against previous weapon systems. There has also been an increase in the number of “urban myths” which surround body armour and its use, which have served to unnecessarily undermine confidence in the procurement and wearing of body armour.

The safety of police officers and staff is paramount to policing and such incidents and issues have understandably focussed attention on the need to create a consistent, objective and informed quality framework (see Figure 1) for officer/staff safety. By establishing closer working relationships between the Home Office Scientific Development Branch (HOSDB), the Association of Chief Police Officers (ACPO), staff associations and forces, quality frameworks to provide the necessary advice could be developed.

It is important that such guidance and support is seen as objective and does not solely rely on advisors with commercial interests.

In seeking to develop such a quality framework, HOSDB and ACPO, supported by both staff associations and the Health and Safety Executive, undertook to provide body armour presentations (also called road shows) to all forces in the UK. In the course of the presentations a number of emerging issues were identified and resolved, from which relevant learning points and good practice were recognised and incorporated into subsequent presentations and this document.

The presentations to forces, which began in 2005, have now been completed and have resulted in universal appreciation for the advice, guidance and reassurance provided, with some forces achieving considerable savings in respect of unnecessary body armour procurement.

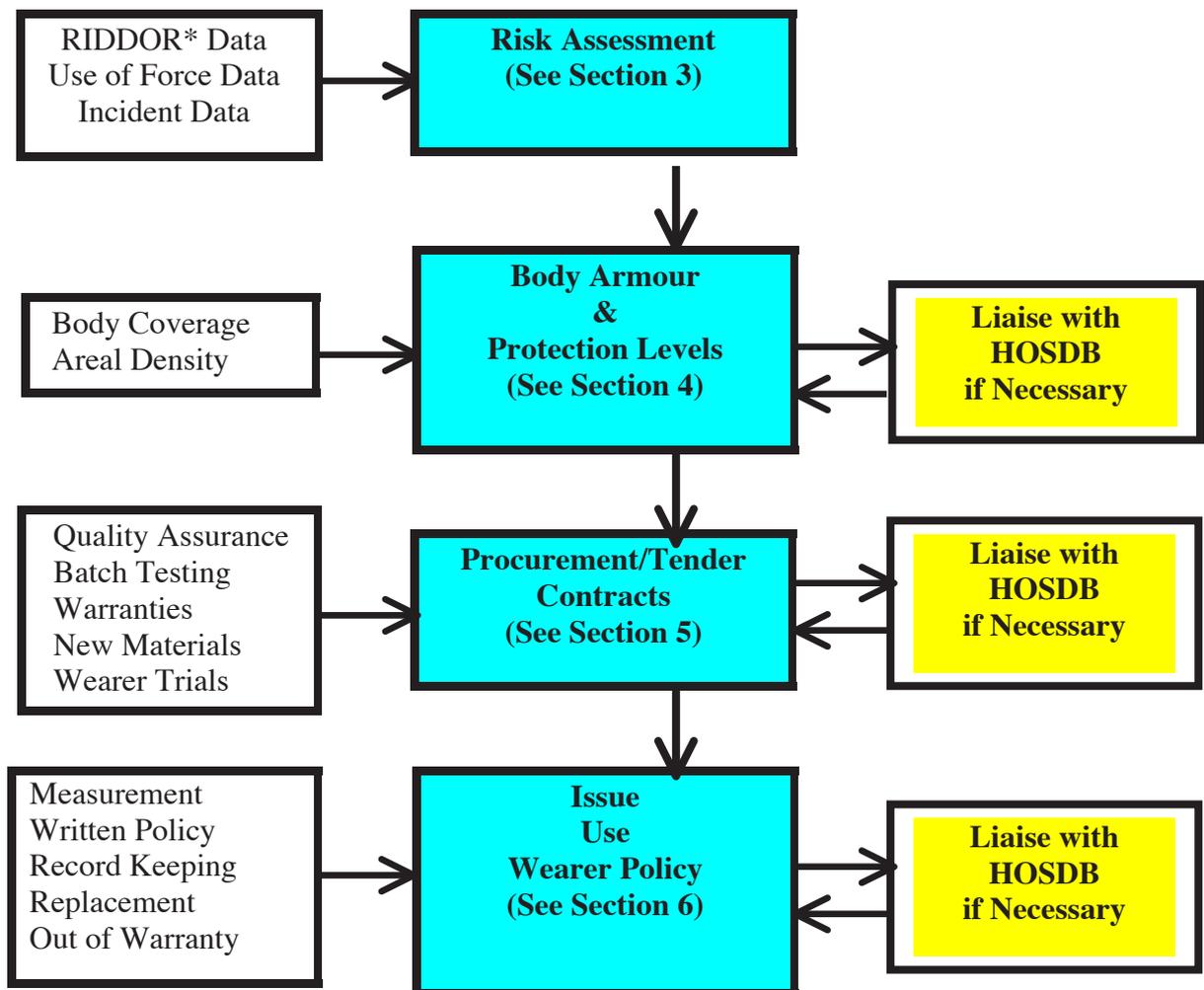
During the presentations forces asked whether a quality framework document could be produced that outlined some of the key aspects of risk assessment, officer/staff safety and body armour and its procurement. It was envisaged that such a document could provide a practical reference document for forces and a means to increase officer/staff safety and improve the effectiveness, efficiency and quality of body armour provision, policy and practice.

## 2 Aims and Intentions

This quality framework report aims to standardise the procedures on risk assessment and to raise awareness of procurement/threat levels and health and safety issues when choosing, procuring and using body armour.

It aims to do this by providing a good practice guide to the whole process of officer/staff safety issues, including quality management, policy and practice. It is intended to provide a generic and consistent quality reference document for forces to assist them in undertaking the required processes and asking the necessary incisive questions of manufacturers.

It is also intended to improve the ability of forces to work together both operationally and in achieving economies of scale. Finally it is intended to provide a reference point for forces to assist them in obtaining objective expert advice and support in response to emerging issues and operational incidents.



\*Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (1995)

FIGURE 1 *The Quality Framework Process*

# 3 RISK ASSESSMENT

The very nature of policing means that it is a risky occupation; to completely remove that risk would mean that police officers/staff would be unable to carry out their role effectively, therefore staff safety becomes an issue of risk management not risk removal. Central to that risk management is the undertaking of timely, realistic and informed risk assessments.

When the use of body armour was first being considered, the main factors that forces took into account in determining the level of risk, and with it the potential benefits of body armour, was restricted to the number of recorded ballistic and sharp edged weapon threats/attacks on officers. However, in recent years there has been a greater appreciation of the far wider range of benefits that body armour provides to staff.

The establishment of the 'Good News - Bad News' database, which seeks to identify all incidents where officers themselves feel that injury, has been prevented or reduced by the use of body armour, has shown a much wider area of benefits than previously identified. These include:

- **Ballistic Attack**
- **Edged Weapon Attack**
- **Non-Edged Weapon Attack**
- **Blunt Trauma Attack**
- **Road Traffic Accident**
- **Accidental Injury**
- **Animal Attack**
- **Role Related Injury.**

Along with ballistic and sharp edged weapon incidents, other potentially fatal injuries that have been avoided through the use of body armour include; an officer who was hit by a stolen car whilst deploying 'stinger'; an officer falling onto a pointed metal fence post whilst pursuing a suspect; officers being involved in Road Traffic Collisions (RTCs), an officer falling from an assault ladder whilst undertaking firearms training, numerous blunt trauma attacks and attacks by dangerous animals. Such events provide a clearer understanding of the real benefits being provided by the wearing of body armour.

They also highlight the fact that the traditional approach regarding the selective wearing of body armour only at times of perceived threat from ballistic or sharp edged weapon attack, fails to appreciate the real protection afforded to officers and staff from these wider areas of occupational threat at all times.

## 3.1 Realistic Risk Assessment vs Overnight Experts

One force visited on the road shows had recently been carrying out a risk assessment of all areas of policing in order to determine and procure a new generation of body armour for the force. In doing so, they had been advised by the firearms department that they needed ballistic-only body armour, as they were additionally protected by their firearms. This advice concerned the procurement officer who contacted HOSDB for advice.

HOSDB's advice was that ballistic body armour will not provide sufficient protection from a sharp edged weapon or spike attack. Also, there were numerous examples of firearms officers being subjected to a knife attack (at least one [not in the UK] of which was fatal) before they were able to discharge their weapon in protection.

Therefore the only way that ballistic only body armour would be recommended is if the risk assessment identified that there was no threat from a sharp edged weapon. As approximately 40% of incidents that firearms officers attend involve a sharp edged weapon threat, such a risk assessment was highly unlikely. The force subsequently chose hybrid body armour that provided both ballistic and sharp edged weapon protection.

In order to remain current, proportionate and relevant, risk assessments need to include an evaluation regarding such risks posed by blunt trauma attacks. These risk assessments should also be regularly updated. ACPO officers need to make themselves aware of when the last force operational risk assessment was carried out and what data the assessment included.

The road shows found that (in some cases) there was little awareness by ACPO officers of the current state of their respective force risk assessments and whether their Personal Protective Equipment (PPE) matched that risk, a factor that becomes critical in the event of a serious or fatal incident. This ACPO awareness is also particularly relevant as body armour is specifically identified as PPE and therefore carries specific legislative responsibilities for Chief Constables.

### 3.1.1 Overview of Risk Assessments

It is critical that ACPO officers maintain an executive overview of all aspects of operational policing strategic decisions in order to ensure that consequential risks to other operational areas are taken into consideration.

An example of this problem was discovered during the course of the road shows when it became apparent that a growing number of forces were increasing the penetrative capacity of their firearms departments by changing from the established H&K MP5 to H&K G36, as a result of perceived changes to the threat levels. However, in doing so forces may not have fully considered the implications of such a change on the officer's body armour.

One of the risks facing firearms officers is from accidental discharge. The HG2 protection level (HOSDB recommendation for AFOs) was specifically designed by HOSDB to provide full five major organ protection from 9mm carbines, which at the time were the general issue weapon. However, without rifle plates (RF1), HG2 body armour does not provide sufficient ballistic

protection against the higher velocity, smaller calibre rounds fired from the G36.

This means that in the event of an accidental discharge, unless an officer is wearing RF1 plates in their HG2 armour (this arrangement does not offer full major five organ protection), they will not be protected and subsequently may receive a serious or even fatal injury.

Few forces visited had specifically factored this issue into their strategic decision-making process when seeking to balance the risk assessment. They were advised to re-evaluate their risk assessment to include consideration of the issue in order to provide a comprehensive risk benefit analysis from which the necessary policy, strategy and tactics can then be developed.

Whilst generic patrol armour such as HG1/A, HG1, KR1 and KR2 will suffice for the majority of policing roles, there is a need to undertake specific risk assessments for specialist roles which may require different protection levels and designs of body armour; So it is important that risk assessments are role specific.

The decision to provide a specific protection level of body armour must be based on a realistic local assessment. It is therefore essential that supervisors, managers, officers and staff are reminded of the importance of completing the requisite RIDDOR and 'Use of Force' forms, so that an accurate evaluation of the changing risk to staff can be produced.

In this way the wider risks and benefits to be gained from the wearing of body armour can be more easily and accurately identified; a factor which also has direct implications for force operational and wearer policy, practice and design.

Forces should also consider informing HOSDB of such incidents in order that the HOSDB/ACPO Good News Bad News database can be kept up to date.

During the body armour road shows officers and their representatives asked about the protection level and availability of specific covert body armour. Such armour also has to be based on the risk assessment involved in covert operations. In this respect the level of protection is the same as for uniform officers with HG1A/KR1 being the minimum level recommended, depending on their role and whether the risk is ballistic or edged weapons or both.

The ideal balance would be to find suitable protection based on the threat assessment that meets the identified risk whilst not impinging on the covert or other specialist role undertaken.

As part of the risk assessment it is necessary to balance the potential risk to covert officers from their identity being compromised against the direct risk from edged weapons or ballistic attack. In this respect there may be circumstances where it is decided that even covert body armour cannot be worn. However, in such circumstances other steps and tactics will need to be taken to minimise the identified risk and such decisions will have to be clearly audited in the operational risk assessment.

Recognising that continual formal risk assessments can be time consuming, it may be possible to update an existing operational risk assessment on a regular basis as part of a force's National Intelligence Model (NIM) strategic

assessment, which by its nature reviews the existing and potential threat to both the community and police staff on a six monthly basis.

By using the strategic assessment as a guide, forces will be able to determine whether the risk to officers and staff has increased or decreased and whether there needs to be any adjustment to the existing formal risk assessments.

The Health and Safety Executive recognise that policing is an inherently risky occupation, therefore, the wearing of body armour should be the default position for officers and risk assessments should be used to identify the occasions when body armour does not need to be worn. This is an approach now being adopted by the majority of forces and one which is supported by the wider range of identified benefits in terms of reduced/prevented injury being experienced by staff.

## **3.2 Comfort - Protection Levels and Threat Levels**

Body armour (in common with most items of PPE) is a compromise between comfort and protection.

It is important that wearing body armour does not put a police officer at greater risk through weight and flexibility consequences, than the threat it is designed to protect against. Comfort can be difficult to define and can change with the perception of the wearer. What might be perceived by the wearer as uncomfortable when there is a low risk of attack can appear to be very comfortable when the risk is real and immediate.

Body armour only protects those parts of the body it covers. If someone is not wearing armour because they perceive it to be uncomfortable or unsuitable then they receive no protection at all.

### 3.3 Body Coverage (The Five Major Organs)

The criterion agreed by ACPO for successful body armour is one that prevents serious or permanent injury. To do this, armour must provide sufficient coverage to protect the five major organs in the torso, namely: **HEART, LUNGS, LIVER, KIDNEY'S AND SPLEEN**, whilst still meeting the ergonomic needs of the wearer. The message here is:

**Do not even consider purchasing body armour that does not protect the five major organs.**



**FIGURE 2** *Body Armour Coverage*

Manufacturers can keep weight down and increase the flexibility and comfort of armour by ‘feathering’ (tapering) the edges of the protective material, which also reduces the area of full protection. During the road shows a small number of body armours were being worn by some officers present that quite clearly did not afford sufficient protective coverage (see figure two left picture). Forces and officers need to be aware of this necessity and ensure that only body armour which provides full protection to the major organs is procured and worn.

#### 3.3.1 Don't be too inflexible on protection levels

If for lightness and flexibility reasons a minimum level of protection is specified such as HG1/A+KR1, it is usually better to specify a ‘minimum’ of HG1/A+KR1 rather than just simply HG1/A+KR1. This way the wearer may get offered extra protection e.g. HG1+KR1 for the same weight/flexibility and cost as each manufacturer’s products (weight etc) often differ. This approach gives the purchaser the choice of accepting an increase in protection if the overall weight and comfort of the armour has not been compromised.

### **3.3.2 Know the difference between weight and ‘areal’ density**

The areal density refers to the weight of an armour construction per square metre. Generally speaking, between two and four complete body armours can be made from 1m<sup>2</sup>. So, if the areal density of a typical dual purpose (ballistic + stab) armour is 7.5 kg/m<sup>2</sup> then a body armour made from this construction would weigh between 1.875 – 3.75kg.

### **3.3.3 Consider having some bulk in your armour**

You will get the bonus of low velocity blunt trauma protection against kicks and punches, road traffic collisions etc. There have been many incidents where body armour has protected the wearer – not from ballistic and/or stab attack but from major blunt trauma injury. However such bulk always needs to be balanced against the comfort requirements of the wearer.

## **3.4 Blunt Trauma Protection**

In one particular incident, an officer was in the process of deploying the ‘Stinger’ device when the vehicle he was trying to stop struck him at speed propelling him over the vehicle. The officer suffered dislocation of his fingers and a fractured sternum. However, the medical consultant who treated him was convinced that had the officer not been wearing body armour then the injury he sustained would have been even more serious or even fatal.

(For full details of Protection Levels see the current HOSDB Body Armour Standards)

## **3.5 PROCUREMENT/TENDER/CONTRACTS**

### **3.5.1 Procurement/Tender**

Because of the specialist nature of body armour, procurement is best undertaken on a project basis with a representative working group ensuring that the interests of the wearers and the needs of the force are taken into consideration. Most project groups also include representatives from health and safety and staff associations, as well as a representative cross section of end users.

This representation is particularly important in respect to female officers. It is also recommended that a quality assurance manager for the project is nominated at this time to be responsible for examining all aspects of quality in respect of the manufacturing process.

A number of forces are working together in collaboration to procure their body armour; this has mainly been done on a regional basis where the risk assessment indicates that both the risk, and therefore the protection level of armour, is the same.

In trying to maximise economies of scale, there is no valid reason why more forces should not consider joint procurement for the provision and replacement of armour where the risk assessment indicates that the same protection levels are required. A number of forces had voiced their support

for such an approach especially when trying to negotiate the provision of smaller numbers of armour. However, the lack of an effective database, detailing the required protection levels and current armour used by forces, had made increased collaboration difficult.

Having decided on the protection level of body armour required, the technical specifications and the commercial and operational requirements, tenders can be invited from suitable manufacturers. It is important that realistic timescales are given to manufacturers when placing tenders for body armour to allow for the necessary design/testing/wearer trials and completion. Ideally a minimum of 12 weeks is recommended to ensure that the majority of manufacturers/suppliers can respond with the best that they have to offer in respect of protection levels and quality and suitability of product.

## **3.6 Quality Assurance**

**(For more comprehensive information see Appendix 'A')**

Quality assurance should be designed to ensure that there is a clearly defined build standard and a transparent audit trail on all materials used within body armour. It is highly desirable that tendering manufacturers hold registration to **BS/EN/ISO 9001:2000** or similar as this will ensure that they will already have a robust and continually assessed system of quality management in place which is available for scrutiny.

For those manufacturers without such registration, forces need to satisfy themselves that they supply details of how they will comply with the specified standard and provide a statement of compliance against each individual paragraph of specific area of **BS/EN/ISO 9001:2000**. Manufacturers are responsible for the Quality Management of their sub-contractors.

The following list of criteria should be considered for inclusion in the initial tender/purchasing document or quality plan:

- **Design processes including those sub-contracted**
- **Goods and materials inward control**
- **Sub-contractor control**
- **Production test regime**
- **Non-conformance control**
- **Failure investigation**
- **Material traceability and batch definition control**
- **Manufacturers nominated representative of quality management**

### 3.7 Quality Control/Batch Testing

The inclusion of suitable quality standards and batch testing is ultimately the responsibility of the relevant forces and has to be an integral part of the procurement contract. In choosing suitable manufacturers it is important to stipulate in the tender document that the supplier will provide evidence of continued quality control in order to ensure that all armours are made to an identical build standard which meets the protection level required. This should include an agreement to maintain a stringent batch testing programme. This could also involve the additional consideration of forces submitting random samples of 'in service' armour for testing at intervals throughout the warranty period of the product.

Any subsequent contract should contain a 'product liability' which covers the life of the product. There are occasions when manufacturers may need to change the specification during the life of a contract as a result of unavoidable external environmental issues, such as the unavailability of materials. If major changes to production/materials do take place then the product should be re-assured as part of the change management to the original 'frozen design'. Any changes to design, production or materials after the contract is agreed should be covered under ISO 9001 and changes must be agreed by the customer.

One issue that prompted the body armour road shows was the reduction in protection level provided by a specific model of body armour. The circumstances were that a body armour designed to provide HG1/KR2 protection, had to be modified to remove the odour that the armours were giving off. To rectify the problem the manufacturing process was altered.

Although the manufacturer had been assured by their sub-contractor that the process changes would not affect protection levels, it was subsequently found that the changes had reduced the armour to a lower level of protection.

Unfortunately because there had been no intermediate batch testing carried out as part of the contract, the problem was not discovered for some time resulting in large quantities of armour being reclassified, recalled or modified. Ultimately manufacturers are responsible for the quality management of their sub-contractors.

This issue serves to illustrate the need for a comprehensive and timely quality management and batch testing processes to be incorporated into any contract with manufacturers.

## 4 BODY ARMOUR TESTING

An extremely important part of quality management for body armour is the testing regime which also needs to be an integral part of the contract. Owing to the destructive nature of testing there will be a cost implication which should wherever possible be included in the overall tender price.

A suggested testing protocol for statistical sample testing (on HOSDB certified armour) has been developed by HOSDB. Manufacturers Quality Testing (MQT) (see 4.1.1) caters for production testing by the manufacturer and also covers in-service testing of operational armour.

Another test protocol used extensively in the manufacturing industry can be found within BS: 6001: Part 1: 1991. This is also based on statistical principles and provides a disciplined means of assessing the quality of the products supplied. In order to ensure confidence in a new product design the test regime should start at a high level and as confidence increases the number of items tested can be decreased.

Some manufacturers undertake V50<sup>1</sup> testing which serves to measure the actual protection/failure level of armour (as opposed to demonstrating that it exceeds a particular requirement). This requires undertaking tests to relate the minimum requirement (V0) and the V50. Then a useful production test regime can be set up to monitor the actual performance of the armour during production by measuring the V50. Such testing can also provide data that can be used to assess the long-term performance of the armour in age testing.

In-service ('dip') testing should be completed throughout the product's lifespan and this should commence after the first year of issue. These results should be compared against the original testing results and will indicate whether the performance of the armour has dropped below the original protection level. In-service testing should be completed annually throughout the operational lifespan of the armour and can be used to justify continued usage after the expiry of the manufacturer's warranty.

### 4.1 Manufacturers Quality Testing (MQT)

Manufacturers Quality Testing (MQT) is a suggested method of ensuring the continued quality of an armour model once it has met the requirements of the HOSDB compliance test. It is intended that this method will be used by the police customer at the tender stage of body armour procurement.

If a manufacturer already uses an alternative sampling system, which meets or exceeds the sampling requirements of MQT1, it may be offered in preference providing agreement has been reached with the customer.

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<sup>1</sup> V50 is a method of determining the velocity of a particular round that will cause 50% penetration of a particular armour model. V100 being the velocity of a round that will cause 100% penetration and V0 is the velocity in which no penetration would result.

Manufacturer/suppliers will be asked to agree to MQT (or alternative as above) at the declaration stage of the compliance testing process. Results of MQT shall be made available to HOSDB upon request.

Full details of MQT are given in the latest HOSDB Body Armour Standards for UK Police (2007) publication number 39/07.

## **4.2 In-force Testing**

The nature of testing body armour is extremely sophisticated, especially in respect of the new generation of lighter flexible HG1A/KR1 armours. Therefore, both formal and informal testing should only be carried out by those with the necessary expertise, experience and equipment. It is critical that forces do not carry out their own unregulated testing as the results will be both inaccurate and potentially harmful in terms of causing unnecessary anxiety and undermining confidence. As an example of this, one force regularly demonstrated the protection qualities of body armour to recruits by shooting at body armour strapped to a water-butt full of water. On one occasion a low level HG1A/KR1 armour was used, resulting in the bullet penetrating through the armour and the water-butt. Rather than seeking expert advice as to why the failure may have occurred, the issue was raised with the media. The result was that officer confidence in wearing the body armour was unnecessarily undermined. Because of their design (and demands for flexibility), body armour is specifically intended to be tested against a soft backing that is designed to emulate the human body. The body armour in question was subsequently tested at a HOSDB approved test facility using the approved method and despite the fact that it had already been shot at, it was found to still provide the necessary protection level.

## **4.3 Warranties**

It is important that the detail of any body armour warranty provided by individual suppliers/manufacturers is carefully checked to determine exactly what the warranty covers as they can vary from manufacturer to manufacturer. Is the warranty merely providing cover against material/construction failure or does it provide assurance against a reduction in the stated protection levels for the whole of the warranty period?

## **4.4 New Materials**

From time to time manufacturers will develop or utilise new materials in the construction of body armour. In the recent past there have been a number of incidents relating to a particular material used in the construction of body armour (USA only) where the protective qualities of such materials have reduced over time or through exposure to moisture to an unacceptable level, which has led to increased risk and injury to wearers. Whilst manufacturers should be encouraged to continue to seek more effective materials, forces need to ensure that any such materials are supported by extensive and transparent testing and it is recommended that they should seek to satisfy themselves that new materials have been subjected to a minimum of five year age testing against the reduction in strength of material and subsequently failure to protect to the intended level.

## **4.5 Overt/Covert/ Carriage of Equipment**

There are both advantages and disadvantages for overt and covert body armour as there are to the carriage of equipment on the outer cover of the armour. Currently more forces are choosing to carry their equipment on the outer cover as a means of spreading the weight of equipment more equally but there are implications.

There are no problems associated with wearing equipment over stab resistant body armour. However, the situation is different for ballistic resistant or dual purpose body armour where the wearing of metallic objects on the outer cover could cause a bullet to either deflect (ricochet) or become 'de-natured' (fragmented or deformed). In the case of the latter, there is a risk that the fragmented parts of the bullet may then perforate body armour that was designed to stop complete rounds rather than protect against fragments.

The risk of a bullet deflected from another piece of issued equipment perforating the body armour is very small, however this must be considered alongside the risk of injury as a result of not carrying equipment when preparing a risk assessment (See section 3)

(See also HOSDB Publication 10/06: Carriage of Police Equipment)

## **4.6 Wearer Trials**

It is extremely important that forces undertake a comprehensive set of wearer trials before a final decision is made to procure body armour. Wearer trials need to include as wide a range of sizes and roles as practicable, using the same officers to try the different models of body armour provided, under operational conditions. It is then recommended that a systematic evaluation is carried out that requires wearers to grade different aspects of the armour being trialled. In this way an objective value based system can be used to identify the armour which is consensually graded the highest.

As a critical part of the timeline for procurement, sufficient time has to be factored in to ensure the necessary completion of wearer trials. It is good practice to give trailing feedback to manufacturers as most manufacturers welcome receiving information (whether good or bad) regarding their products.

## 5 ISSUE, USE AND WEARER POLICY

### 5.1 Measurement

In both trials and in subsequent issue of body armour, accurate measurement and fitting is crucial to the comfort and effectiveness of body armour. This is particularly relevant for female officers and staff as the majority of complaints from female officers stem from inappropriate measuring and fitting. Therefore in any procurement, forces need to ensure that suitably experienced support staff is provided by suppliers. It is also necessary to determine what continued support will be provided during the period of the contract. This may be provided either by manufacturers continuing to provide the measuring service, or for them to provide cascade training for identified force personnel.

### 5.2 Written Policy

Forces should have a clear written policy regarding the issue, use and wearing of body armour, which is understood throughout the force. This is particularly important for those forces who adopt a discretionary use of body armour policy, in order to ensure that officers and staff are clear about the parameters of such a policy.

Such a policy should also seek to ensure that officers and staff are aware of the limitations of body armour and especially the fact that it is knife and ballistic '**resistant**' not knife or ballistic '**proof**'. Therefore, wearers should be careful not to put themselves at any greater risk of personal injury than they otherwise would had they not been wearing body armour.

It is also worthwhile providing staff with guidelines on the maintenance and storage of their armour and a number of forces are now providing pocket aide- memoirs to staff when they are issued with their body armour.

### 5.3 Record Keeping

It is important that forces maintain a comprehensive record of their body armour which identifies the make, model, protection levels and batch number of the armour and to whom it was issued. This allows for a clear audit trail in the event of re-issue or failure of the body armour and ensures that annual checks of the armour can be carried out and recorded as required.

Radio Frequency Identification (RFID) tags are small and unobtrusive (once fitted into a garment) and can be used by forces as a means of recording details of body armour (or other items of PPE). It is an embedded technology that overcomes the disadvantages of visual systems like bar code or reference labels because it is less likely to become worn out or defaced in service such that the identity is lost.

Once the armour/personal equipment has entered service then the force could use RFID tags to positively track and register the PPE to an individual on a database held on the force's intranet for instance.

This is relatively new technology and manufacturers are only just becoming aware of the potential benefits of this method of record keeping. However, it is worth considering as an option when formulating a tender.

## **5.4 Post Incident and Replacement Policy**

Forces also need to be clear about the replacement of body armour particularly after an incident where the armour has been the subject of a stab, ballistic or blunt trauma attack.

Should the armour be subjected to a ballistic attack then it would need replacing due to the 'shock load' (stresses) experienced by the armour fabric as a result of such an attack. However, in respect of a stab or blunt trauma attack it would depend on the extent of the attack and it would be necessary to initially examine the body armour to determine whether replacement was necessary or not.

It is not likely that low level trauma attacks would require the armour to be replaced but if in any doubt, the best policy would be to replace the armour.

## **5.5 Serviceability and Out of Warranty Replacement**

It is recommended that body armour is checked at regular intervals - either annually or otherwise as the force decides - to ensure that it is in serviceable condition and forces are advised to introduce a system whereby reminders are provided for staff.

Such checks need not be onerous, but can serve to ensure there is no extensive damage or that the water resistant body armour cover has not been breached allowing in moisture, which may limit effectiveness.

Most forces designate staff supervisors to undertake these checks and a small number have tasked their supplier to carry out inspections and refurbish as required. This can be agreed at the tender stage.

In the same way that vehicles are not replaced after the warranty expires, there is no need to replace body armour merely because it is out of warranty. However, there is a need to ensure that the armour is still serviceable and this can be done by negotiating with the manufacturers to carry out a dip-sampling process of a small percentage of samples. Appendix B gives a suggested test regime for in-service armour.

Also see body armour testing section 4.

## **5.6 Body Armour Carriers**

The designs of carriers are quite rightly the preserve of individual forces. However, there are now a number of options available to forces that can extend the area of protection without unduly compromising the comfort or wear ability of the body armour.

It is envisaged that the new HOSDB Slash Standard (publication No 48/05) will encourage manufacturers to develop slash resistant materials which will be suitable for attaching to body armour carriers. Such developments could provide additional protection to other areas of the body by the addition of, for example, removable or adjustable collars and sleeves.

Although this is an ongoing development by manufacturers, we would recommend that when procurement for body armour is sought, enquiries are made with manufacturers to establish whether such options are available.

## 6 Acknowledgements

Grateful thanks are given to PC Shaun Winslade of the Metropolitan Police Service for his contribution to the Quality Assurance Requirements section (Appendix A)

# Appendix A: Quality Assurance Requirements for Body Armour

*The following is a summary from the actual quality requirement document for body armour used by the Metropolitan Police Service.*

“The need to ensure that there is a correct and well-managed quality assurance programme within any body armour contract is essential, in order to ensure that armour is correctly constructed and meets the specification set out in the contract.

Whilst the Home Office Scientific Development Branch (HOSDB) in the UK, The National Institute of Justice (NIJ) in the US and other member states in the EU have test standards, these standards are an indication of the protection level that the individual armour tested meets. It cannot give assurance that all armours made to an identical build standard will continue to meet the protection level required.

Quality assurance ensures that there is a defined build standard and an audit trail on all materials used within body armour. This becomes more important when large batches of armour are supplied throughout the lifespan of a contract. The audit trail must be able to identify all aspects of material usage to ensure that the source of any problem is easily and quickly identifiable.

One of the main areas of quality focus will be the production test regime placed on the contract. The test regime implemented by the manufacturer will need to be clearly evidenced, and where necessary a stricter regime implemented to ensure compliance with the contract.

The destructive nature of body armour testing will have cost implications for the contract and should wherever possible be included within the overall tender price. This issue needs to be fully explored with the contract holder to ensure that best value is attained whilst guaranteeing the protective ability of armours.

The test regime for sample testing used extensively in the manufacturing industry can be found within BS: 6001: Part 1: 1991. Sampling plans are categorised in terms of acceptable quality level (AQL), of batch sizes ranging from 2 – 500000. BS 6001 is based on statistical principles and provides a disciplined means of assessing the quality of the products supplied. To ensure confidence in a new product design, the test regime will generally start at a high level and as confidence in the model increases (statistical testing can ensure this) the number of items tested may be decreased.

The nature of body armour testing is such that there is inherent scatter in the test results. Initial testing requires a minimum number of successful shots to be achieved before the model can be accepted. Even so, a greater level of testing on new designs provides a greater degree of confidence that the minimum protection requirement is met. However, this increased level of testing will be expensive so a compromise must be agreed.

One method for measuring the actual protection level of armour (as opposed to demonstrating that it exceeds a minimum requirement) is to undertake V50 testing. Simply, this method finds the velocity of the bullet that will cause 50% of the shots to penetrate the armour; the remaining 50% would be held.

Then a useful production test regime can be set up to monitor the actual performance of the armour by measuring the V50 at pre-determined intervals. This can also provide data that can be used to assess the long-term performance of the armour in age testing.

Age (in service) testing should be completed throughout the products lifespan commencing after the first year of issue. These results should be compared against the original batch testing results and will indicate whether during operational wear the performance of the armour has dropped below the required level. Age testing should be completed at regular intervals (usually annually) throughout the operational lifespan of the armour and can be used to justify continued usage after the expiry of the manufacturer's warranty. All data on the test regimes must be located at one central point and as with all the issues surrounding purchasing, ideally, this should be the procurement file.

The above advice on test regimes is one small area that fits within the quality management framework. Other issues need to be addressed throughout the purchasing process and post contract award.

## **A.1 Pre Contract**

The first phase of any purchase will be a tendering exercise. This will include the drawing up of the technical specification, commercial and operational requirements. It is at this stage that the group overseeing this procurement process must be established. It should be representative of the various parties that will have involvement in the procurement action.

The quality assurance manager will examine all aspects of quality within the manufacturing process and this will also include test regimes that the suppliers place on their inward supply of materials. The test regime agreed by the manufacturer and the purchasing authority will be overseen by a Quality Assurance Officer (QAO) and the technical expert.

## **A.2 Technical File**

To assist the quality review and technical assessments that will be conducted through a procurement action a technical file should be requested from the manufacturers/suppliers competing for a contract. This file must contain the following information:

- **Build standard of design including materials, drawings, construction methods, fittings etc.**
- **Brief report of product development, including summary of design rationale, choice of materials, construction, design calculations, development test results etc.**
- **Details of any similar product delivery to other agencies**
- **Details of subcontractors and suppliers**

- **Summary of proposed production processes, including subcontractors activities, goods inward control, material traceability, non conformance control and production sampling regime**
- **Wearer instructions including adjustment instructions**
- **Label printing details ( base material and inking data)**
- **Certificate of conformity with respect to protection performance requirements**
- **All details in the technical file will be regarded as confidential and only communicated on a needs basis.**

### **A.3 Tender Documentation**

The following criteria should be included in the initial tender/ purchasing document to ensure that any company stating an interest in the supply of armour has a quality regime in place. This provisional quality plan must be contract specific, and is to include the following;

- Design processes including those sub contracted;
- Goods inwards control;
- Sub contractor control;
- Production test regime;
- Non conformance control;
- Material traceability and batch definition;
- Nominated representative of quality management.

It is desirable that the tenderer holds registration to BS/EN/ISO 9001:1994. This identifies the processes that will be used in the manufacture and design of the armour.

If a tenderer does not have BS 9001 registration they should be asked to supply details of how they will comply with the specified standard. They should also be requested to provide a statement of compliance against each individual paragraph of BS/EN/ISO/9001. In particular the tenderer should provide details of their design control process that shall be applicable to the contract.

The potential suppliers must nominate a representative with authority to resolve matters pertaining to quality who will liaise with the relevant purchasing authority. They should also state the sub contractors and suppliers who will be employed during the contract and they should declare subcontractors previous experience in similar contracts. The procurement authority should reserve the right to audit and approve the quality management systems of subcontractors.

## **A.4 Quality Plan Content**

Although part of the technical file of armour the following information will be required from the potential supplier to assist in the quality plan.

### **A.4.1 The build standard of design including materials, drawings construction methods.**

This will play an important part in the procurement process; once selected this build standard cannot be altered without the agreement of the purchasing authority. This ensures that every body armour supplied is constructed from approved materials to the defined build standard.

The majority of body armour supplied within the UK Police market is a mixture of armour designs and materials. These designs have developed and been enhanced through new materials and ideas. It is essential that the rationale for a particular armour design be explained in full. The development test results will be a significant factor, as this will indicate how many tests have been conducted to justify the design build of particular armour.

### **A.4.2 Specification sheet**

Required to ensure that all aspects of the armour are recorded and the build standard meets the relevant levels set in the specification for the armour

### **A.4.3 Details of any similar product delivery to other agencies**

Where the supply of armour to another customer is identical or similar to that being purchased details should be required and used as evidence that the quality of these products meets the requirement and any problems that may have occurred have been identified and remedied.

### **A.4.4 Details of subcontractors and suppliers**

A normal requirement placed on any contract would be the identity of the above. For the purpose of body armour it is essential that the quality systems put in place by sub contractors and the main contractor are relevant and allow for auditing. Both quality systems must dovetail to ensure that compliance with the quality plan is met at all stages. The prime contractor shall be responsible and accountable for the products and services, including design, provided by their subcontractors and suppliers.

### **A.4.5 Summary of proposed production process including sub contractor activities and production test sampling regime to meet the requirements**

Following on from above this is an extension of the information required. The production process and the role of the subcontractors within a contract need to be detailed exactly. This enables each separate activity to be identified and

therefore inspected. No part of the production process should be overlooked within the quality plan.

#### **A.4.6 Certificate of conformity with respect to protection performance requirements e.g. HOSDB Certification**

This ensures that the product supplied meets the requirement set down in the purchasing requirement. A test centre report form can evidence this requirement.

#### **A.4.7 Contract Stage**

At this stage the quality plan will have been examined and agreed by all parties. It is essential that during the initial stages of manufacture the test regime accepted by the purchasing authority should be monitored very closely. All aspects of the manufacturing process should be examined to ensure that compliance with the specification is met in all areas. The purchasing authority must deal with any areas of non-compliance with the relevant representative nominated by the company.

During the contract it is beneficial to all parties to hold regular meetings, these will ensure that areas of quality and any areas of research and development that may be undertaken are strictly monitored and controlled and where necessary implemented. These meetings should also be used as a structured means to address quality issues that will be fed back into the system by the users.

Should quality issues arise due to non compliance with the specification, it is important that a system is in place to identify any armours that may be effected and ensure that they are examined. Where faults occur it may become advisable to stop all batch deliveries until the problems are rectified. If this occurs the level of testing should be increased until confidence in the product returns”.









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