CONTENTS

1. PURPOSE

1.1 Motorcyclists represent one of the most vulnerable road user groups in the UK with around 330 riders losing their lives each year on our roads. Of these, 80% receive strikes to the head and in 70% of these the head injury is the most serious injury.

Collaborative research published in 2001 that was gained through original, collaborative scientific research revealed that better designs of safety helmets could deliver a real road safety benefit. This work estimated that an increase in helmet energy absorbing characteristics of 30% would reduce 50% of AIS 5-6 casualties to AIS 2-4. Further analysis showed that 20% of AIS 5-6 casualties could be reduced to AIS 2-4 if the energy absorbed by the helmet could be increased by 24%[1]. The research concluded that these better helmets were feasible in the market place but despite this evidence, developments in motorcycle helmet technology remained largely static.

Following a review of the standards and laboratory tests that revealed real differences in the safety performance of motorcycle helmets available in the market, the Department for Transport launched the Safety Helmet Assessment and Rating Programme (SHARP) in 2007. This scheme provides consumers with an independent and objective assessment of the safety performance of helmets sold in the UK.

To date SHARP has published ratings for over 380 models of full face and flip front helmets and successfully provides the ratings to a large number of consumers. Whilst the majority of the SHARP programme is managed by the Department, the physical testing and storage of tested samples aspects of the programme are contracted to a specialist test laboratory. This work specification sets out the Department's requirement for a test facility to perform the physical impact testing of motorcycle helmets and provide storage of helmets samples that have been tested. We expect the contract to run from September 2016 to August 2018. Whilst it is anticipated that this contract will run for 2 years, the Department will review the programme after 12 months and a break point has therefore been included 12 months after contract award.

2. BACKGROUND TO THE CONTRACTING DEPARTMENT

2.1 Department for Transport

The Department's long term vision is to ensure that Britain remains a world leader on road safety. There have been large improvements over previous decades and recent years and the Department is committed to ensuring that this trend is maintained. Each year, around 1,700 people are killed, 21,000 seriously injured and around 160,000 other people suffer less serious injuries in road accidents in Great Britain each year[2]. As part of the Government's strategy to continue the trend in reducing the number of deaths and injuries on our roads, a commitment has been made to continue supporting the SHARP consumer information programme[3].

[1] COST 327: Motorcycle Safety Helmets. Final Report of the Action, 2001.

[2] Reported Road Casualties in Great Britain: 2013 Annual Report

[3] DfT British Road Safety Statement, December 2015

3. BACKGROUND TO REQUIREMENT/OVERVIEW OF REQUIREMENT

3.1 The Department was a co-sponsor of the work of COST 327 (the largest European study into motorcycle casualties) and commissioned further scientific work to build upon the evidence that this programme provided. This considered not only the management of the impact energy but also those areas of the head that are most likely to be struck, the magnitude of impact and the risk of brain injury from that impact.

As a result of this work, SHARP was launched in 2007 to provide motorcyclists with clear and objective advice concerning the level of protection that helmets available in the market place provide together with guidance on selecting a helmet that fits correctly so that an informed choice can be made when purchasing a new helmet. The scheme provides an independent comparison rating concerning the level of protection a helmet can offer a rider on the road by using a simple star rating system; 5 stars being the highest.

This information is primarily disseminated through a dedicated website (www.direct.gov.uk/sharp) but in addition to this, dealers and training schools can obtain free leaflets etc to pass on to their customers and manufacturers can request SHARP rating logos for use on their products. The programme also utilises stands at a limited number of UK motorcycle shows each year to directly interact with consumers and traders.

Given the demand for information from consumers (an average of 84,000 visits to the website each month, 20,000 rating leaflets distributed each year and the increasingly widespread use of SHARP material by manufacturers in their advertising campaigns) SHARP influences the purchasing decision of a large number of motorcyclists.

As part of wider research for DfT in 2015 looking at how effective SHARP has been in influencing the UK market, a survey of motorcyclists found that, of those respondents aware of SHARP, almost 90% said that the SHARP rating was an important factor in their purchasing decision. Surveys for other organisations have also provided an indication that SHARP is widely used; of 1000 motorcyclists surveyed for the insurer Carol Nash, 77% were aware of the SHARP safety rating awarded to their helmet and 70% of these had a helmet with 3 or more stars.

4. DEFINITIONS

Expression or Acronym	Definition
yymmdd	Where this date format relates to the date that a helmet model is tested, this means the date on which the testing of that model was completed.
DfT project officer	Means the DfT official responsible for managing the Safety Helmet Assessment and Rating Programme (SHARP) – helmet performance testing – phase 3 contract with the successful supplier: The “Contract manager”.

5. SCOPE OF REQUIREMENT

5.1 The Department for Transport does not have the facilities to carry out the physical testing that is needed to measure the ability of helmets to manage impact energy and is therefore looking to appoint a competent laboratory that will;

I. Use high quality apparatus to subject a number of approved motorcycle helmets to a series of precise and accurate impact tests in the way prescribed and to the tolerances set out in this work specification.

II. Supply the Department with a comprehensive technical file for each model of helmet that is tested.

III. Provide the Department with technical advice relating to any test procedures or results provided.

5.2 All helmets used as part of this programme will be selected and supplied by the Department for Transport.

5.3 Apart from the test equipment that will be supplied by the Department (see paragraph 22.1), the successful tenderer will be expected to provide all other equipment needed to perform the required tests. The department does not anticipate there being a need to fund either in part or full the necessary test rig and associated equipment.

5.4 Tenderers are invited to demonstrate how they could meet the requirements of this work specification. If there are any areas of this work specification that tenderers would not be able to meet in full, these must be highlighted in their tender.

6. THE REQUIREMENT

6.1 Helmet storage.

The contractor must be able to provide a helmet pre-test storage facility that is a clean, safe, secure, and with a temperature controlled at 25 degrees +/- 5 degrees Celsius. Helmets that have been tested shall be stored for a minimum of 8 weeks in a safe, secure environment before being destroyed. Given that one sample is usually retained from each model that is tested and that helmets are tested in batches of around 15 models, the contractor shall be able to accommodate the storage of around 900 helmets. Samples of models previously tested should be available during any site visit by the project officer.

6.2 Test apparatus.

All test apparatus shall provide repeatable tests. Tenderers are invited to provide evidence of the repeatability of their existing test apparatus or demonstrate how repeatability shall be achieved if the specific test apparatus is not yet available. The nature of the project means that the test equipment used for this contract must meet the requirements set out in Annex A of this work specification to ensure consistency with tests previously performed for the SHARP programme.

The Department will provide certain elements of the necessary test equipment for the duration of the contract. It shall be the responsibility of the contractor to store, manage and maintain any test equipment supplied by the Department for use in this project. Subject to agreement with the project officer, the contractor shall arrange for the replacement of any equipment supplied by the Department that may break or fail during

the testing (the cost of such items will be borne by the Department). The supply and replacement of all other equipment, including standard test consumables, shall be borne by the contractor.

Any equipment supplied by the Department shall not be used for any purpose (including research, development or routine test work) other than that which is specified under the terms of this contract, without advance written approval from the Department's project officer.

The Department may require the contractor to subject helmets supplied by a third party to the SHARP test protocols set out in this document. In such cases, the contractor may be required to invoice the third party directly for any test work that is carried out. The costs to the third party shall be the same as those for the DfT and an electronic copy of any invoice for the third party shall be submitted to the project officer. Other than submission of invoices, all correspondence with the third party in relation to any work that is carried out shall be directed to the project officer.

All equipment supplied by the Department (and any replacements provided under the terms of this contract) remain the property of the Department. Where replacements for indelibly marked equipment are required, these replacement parts shall be marked in the same way as the originals.

Tenderers should clearly indicate when they would anticipate being in a position to carry out the start-up tests specified in section 6.5 below.

6.3 Meetings between DfT and Contractor.

An initial project meeting will take place at the award of contract between the DfT project officer and contractor. Other meetings may be called from time to time by DfT, for example to inform the interested parties (policy makers) on the progress of the project.

6.4 The DfT will chair the meetings and the venues will be at the discretion of the DfT project officer. Tenderers should assume that meetings will be held no more than two times per year. The contractor will provide the secretariat that will take the minutes and agree them with the DfT project officer before distribution.

6.5 Start-up tests.

Before testing begins, the contractor shall perform a series of tests as specified in the Annex in order to become proficient with the test process and to validate their test apparatus and test equipment. The contractor shall be required to complete a maximum of five full model tests and any additional tests will be at the discretion of the project officer. All helmet samples shall be provided by the Department and the cost of tests shall be borne by the contractor. No 'live' tests shall be carried out until the start-up tests have been completed to the satisfaction of the project officer.

6.6 Laboratory Procedures.

The potential for inaccuracies during physical testing shall be minimised. The Contractor shall be responsible for ensuring that tests are completed under strict quality control procedures and with the highest attention to detail. The Contractor shall closely monitor the progress of all testing to ensure the early identification of changes in the performance of the apparatus or the application of the protocols that may impact on the accuracy of the results and report these immediately to the project officer. The

Contractor shall ensure that all testing is carried out to the requirements of this work specification unless otherwise agreed with the Project Officer.

6.7 Technical advice relating to any test procedures or results.

The contractor shall highlight any issues that arise during the test process and advise the Department of possible options for their resolution. It is anticipated that this this provision will require, for the most part, the contractor to simply discuss issues arising (such as, for example, problems obtaining a direct strike to impact sites) with the project officer.

6.8 Site visits.

The Contractor shall be able to host Departmental officials, manufacturer's representatives, or other organisation's representatives to witness tests, view helmet samples and to review results. The contractor shall also be able to provide a suitable facility for officials to discuss or review results with visitors. The Department requires that all Health and Safety requirements are properly considered with respect to on-site visits. Details of the tests and viewing of the testing or post-test samples shall not be conducted without written agreement in advance from the Department's project officer.

It should be noted that the SHARP rating procedure requires that, at some point following the impact testing of each model of helmet, the project officer will need to physically dismantle and inspect the samples that have been tested. The contractor shall therefore be required to provide a suitable environment for this activity.

6.9 Methodology.

The test equipment, test process and the data that the Department requires to calculate a SHARP safety rating for a given model of motorcycle helmet can be found at Annex A. The response to tender will clearly set out how these requirements will be met and highlight any areas that may not be met in full.

7. KEY MILESTONES

7.1 The tenderer should note the following project milestones that the Department for Transport will measure the quality of delivery against:

Milestone	Description	Timeframe
1	Anticipated contract start date	9 September 2016
2	Inception meeting	Within week 2 of Contract Award
3	Completion of the start-up tests set out in section 6.3.	Within week 6 of Contract Award
4	Contract breakpoint	12 months after Contract Award
5	Anticipated contract end date	8 September 2018

8. DEPARTMENT'S RESPONSIBILITIES

8.1 SHARP is managed 'in-house' by officials at the Department for Transport. For the duration of this contract, the department will be responsible all other aspects of SHARP: for the selection and procurement of helmets, oversight of the testing, analysis of the data, calculation of the safety rating and dissemination of the results to consumers.

8.2 The Department will advise the contractor of the helmet models that have been selected/procured for inclusion in the test programme and provide an indication of the likely delivery timescale. It should be noted that whilst orders for the models to be included are placed at the same time, the delivery of certain models may be delayed if they are, for example, new to the UK market.

9. DELIVERABLES

9.1 Project management.

On receipt of the helmet models for impact testing, the contractor shall provide the project officer with confirmation of the samples that have been delivered. Within two weeks of receipt of samples, the contractor will agree with the project officer a timetable for their testing and provide this electronically to the project officer.

The timetable will set out the timescale for completion of key aspects of the test process (i.e. completion of the marking up procedure, linear and oblique impact tests).

The Department may require the contractor to carry out repeat impact tests to additional new helmet samples. These may be required at relatively short notice, perhaps within 3 or 4 days from when the new sample arrives at the contractors' premises. Tenderers should set out how they would meet this requirement paying particular attention to the resources for this requirement and contingency plan should any key staff be unavailable.

9.2 Project reporting.

A progress report shall be provided on the agreed date for completion of the key aspects to the test process. This shall be in electronic format to the DfT project officer. The report must contain:

- provide a concise summary of the completed and in-progress tasks;
- highlight any issues with delivery of the key aspects to the test process and if appropriate, set out a recovery plan.

9.3 Model final reports.

The contractor shall provide a final report for each helmet model tested in PDF format. This shall have a file name in the following format: date of test (yymmdd), the unique test reference number and helmet brand. For example: 130827_301_Shark Evoline lll – test report. The report shall contain:

- Helmet brand name and any Type Approval number displayed on the helmet

- Manufacturers declared helmet shell structural material (e.g. GRP, Polycarbonate, Carbon Fibre)
- Manufacturers declared helmet liner material (e.g. EPS, HDF etc)
- Measured helmet mass (grammes)
- External projections - any significant feature that may affect testing. Photographs should be provided where appropriate.
- Helmet shell symmetry – any deviations in form from side to side.
- Photographs - high resolution images, taken against a high contrast background from the following positions
    - Horizontally, at 45^0 to the front aspect of the helmet.
    - Horizontally, to the front of the helmet
    - Horizontally, to the left side of the helmet
    - Horizontally, to the right side of the helmet
    - Horizontally, to the rear of the helmet
    - Vertically, to the top of the helmet
    - Vertically, to the inside of the helmet

  Where helmets that are tested are supplied in both plain and coloured graphics, the coloured helmet should be used for these photographs.

  The report should also include the five photographs of the 06 sample specified in in section 9.4.
- A unique test reference number and date (the reference number for the first helmet tested under this contract will be provided by the DfT).
- Manufacturer's declared helmet size; actual measured internal circumference and best fit head form.
- External shell size (where a difference in shell size across a model range can be established).
- A copy of the data summary sheet.

This report shall be submitted to the project officer as soon as possible after each model of helmet has been tested.

9.4 Data Summary Sheets.

For each helmet model tested, the contractor shall provide a data summary in Microsoft excel format using the template at 22.17 of the Annex. This shall be submitted to the project officer within two weeks of the helmet model being tested.

Photographs of the helmet model that has been tested shall also be provided with the data summary sheet. These images shall be:

- A single high resolution electronic image, taken against a high contrast background, horizontally at 45^0 to the front aspect of the helmet. The photograph shall be

supplied separately in JPEG format, resized to 190 x 189 pixels, with a file name containing the date of test (yymmdd), the helmet manufacturer and the model designation, e.g. “070328arashiblade”. The layout of the photograph should be as close as possible to the following example:

Where helmets that are tested are supplied in both plain and coloured graphics, a coloured helmet should be the sample used for this image.

- Five high resolution electronic images of the 06 sample after the impact tests have been carried out. These shall be taken against a high contrast background, vertically to the top and horizontally to the front, left side, right side and rear of the helmet. These photographs shall be supplied separately in JPEG format, resized to 190 x 189 pixels, with a file name containing the date of test (yymmdd), the helmet manufacturer, model designation, sample number and direction from which the image was taken, e.g. for the front photograph: “070328 Arashi Blade 06F”.

9.5 Raw Data.

For each helmet model tested, the contractor shall provide:

For Linear impacts the test data shall include complete acceleration / time history and force / time history in each of the three axis of the head form accelerometer. These data will be supplemented by force / time data from the impact anvil load cell. For system (flip-front) helmets that are tested, the instances of any failure of the lower face guard locking mechanism shall be provided.

For Oblique impacts the test data shall include complete normal and tangential anvil forces / time history.

These data shall be submitted to the project officer within two weeks of the helmet model being tested.

10. VOLUMES

10.1 It is anticipated that there will be a requirement for testing 30 full models of helmet per annum. This is likely to be in two batches of 15 models.

10.2 With any repeat tests that may be required, it is expected that this will equate to approximately 950 linear and 70 oblique impact tests in each year of the contract.

10.3 Whilst this is the anticipated volume of tests that will be required, the Department may require additional tests to be carried out (see section 6.2). It is not anticipated that the

number of these additional tests for a third party will exceed 10 full model tests in each year of this contract. Tenderers should indicate whether they would be able to accommodate this requirement.

11. CONTINUOUS IMPROVEMENT

11.1 The contractor will be expected to consider improvements to the way in which the required Services are delivered throughout the Contract duration.

11.2 The contractor should present proposals for improvement to the project officer for consideration. Any changes to the way in which the Services are delivered must be agreed with the project officer before any changes being implemented.

12. SUSTAINABILITY

12.1 The Department will expect helmets to be disposed of in a manner that minimises the impact on the environment. Tenderers should set out how they propose this requirement will be met.

13. QUALITY

13.1 The Tenderer is invited to provide evidence of their in-house Quality Control procedures that would be applicable to the work detailed in this document.

14. PRICE

14.1 The Tenderer is invited to submit costs based upon a requirement for testing 30 models of helmet per year. Costs should be expressed as a cost per helmet model and separate costs separate linear/oblique impact tests that may be needed – as indicated in the table below.

Task	Cost (ex vat)
Full model tests (30 linear impacts and 2 oblique impacts	£Cost per model
	£Cost per 10 models (tested as a batch of 10)
Oblique impact tests	£Cost per 2 impacts to a single helmet
Linear impact tests	£Costs per 5 impacts to a single helmet
	£Costs per 30 impacts

14.2 As indicated in section 6.9, there is a requirement for the contractor to host Departmental officials, manufacturer's representatives, or other organisation's representatives to witness tests, view helmet samples and provide a suitable facility in which to review any results. The contractor will be expected to demonstrate the test procedures, such as marking of the test positions on the helmet, selection of the test headform, impact tests. The contractor will be required to provide the project officer with the data from these tests immediately after the impact tests have been completed.

14.3 It is anticipated that no more than four of these 'witnessed' tests will be needed during each year of the contract, and on each occasion, a single helmet will be subjected to either 2 oblique impact tests or 5 linear impact tests. Tenderers should indicate a cost per helmet for performing these 'witnessed' impact tests:

Task	Cost (ex vat)
Witnessed oblique impact tests	£Cost per 2 impacts to a single helmet
Witnessed linear impact tests	£Costs per 5 impacts to a single helmet

14.4 Any Prices shall remain firm until the end of the contract. DfT invites tenderers to set out detailed and costed proposals that clearly allocate time and resource against the requirements of this specification. Cost information shall include day rates for individual project team members, indicative time involvement per team member per task, and estimated costs for other expenses.

14.5 As set out in sections 6.1 and 17.2, the Department retains one sample from every helmet model that is rated. The contractor will be expected to arrange the collection of these retained samples from a storage facility at Manchester within one month of the contract award. Tenderers should clearly indicate the cost of helmet collection separately in any tender submitted given that this cost will not be considered as part pf the tender evaluation process.

14.6 Prices are to be submitted via Appendix E excluding VAT.

15. STAFF AND CUSTOMER SERVICE

15.1 The Department will require the contractor to provide a sufficient level of resource throughout the duration of the SHARP helmet performance testing (phase 3) contract.

15.2 Tenderers shall declare any existing commercial links or contractual arrangements with motorcycle helmet manufacturers, distributors and suppliers.

15.3 Contractors staff assigned to the SHARP helmet performance testing (phase 3) contract shall have the relevant qualifications and experience to deliver the Contract.

The Department considers that the project team for this work is likely to comprise of experts in:

i) Helmet approval standards or PPE impact testing work

ii) Laboratory impact test work

15.4 Tenderers shall declare any current or previous links between motorcycle helmet manufacturers, distributors, suppliers or testing facilities and the tenderer's staff that may would be assigned to the SHARP helmet performance testing (phase 3) contract.

15.5 The contractor shall ensure that staff understand the Department for Transport's objectives and will provide excellent customer service to the Department for Transport throughout the duration of the contract.

15.6 Tenderers shall nominate a project team manager to be the main point of contact for the Department. Tenderers shall provide CVs and details of both grade and estimated time allocation for individual project team members.

16. SERVICE LEVELS AND PERFORMANCE

16.1 The Department will measure the quality of the Supplier's delivery by:

KPI	Service Area	KPI description	Target
1	Project management	Provide a testing plan (timetable) for the impact testing samples within two weeks of their arrival at the contractors' premises, taking into account any downtime that may be necessary for calibration of test equipment etc.	95% of testing plans to be provided within two weeks.
2	Supply of test data to DfT	Test data generated by the impact tests (data summary sheets (section 9.4) and raw data (section 9.5)) to be provided to the project officer within the timescales agreed in the testing plan.	90% to be provided within the agreed testing timetable.
3	Supply of final reports	Unless by prior agreement from the project officer, final model reports for each helmet model tested shall be provided to the project officer within eight weeks of the test data being provided.	75% within eight weeks of the test data being provided.

16.3 The Department reserves the right to terminate the contract in the event of failure to meet the above targets.

17. SECURITY REQUIREMENTS

17.1 The contractor will be required to dispose of helmets that have been tested in such a way as to ensure that there is no possibility of them entering into use. Tenderers should set out how this requirement would be fulfilled.

17.2 For each model of helmet that is tested, following receipt of the model final report the Department will authorise the destruction of, in most cases, all except one of the test samples. Following authorisation, the contractor shall destroy the helmets and inform the Department of their disposal.

18. INTELLECTUAL PROPERTY RIGHTS (IPR)

18.1 The Contractor shall keep all information gathered during the execution of this contract confidential. The Contractor shall not, without the prior written consent of the Department, disclose any information or results to any party other than to those of its officers, employees and advisors, to whom it may be necessary in order to fulfil this contract.

18.2 All information gathered shall remain the sole property of the Department and the Contractor will be expected to sign a written agreement of confidentiality to this effect.

19. PAYMENT

19.1 Payments will only be made following satisfactory delivery of pre-agreed products and deliverables.

19.2 Before payment can be considered, each invoice must include a detailed breakdown of work completed and the associated costs.

19.3 To ensure prompt payment, a draft copy of invoice must be provided to the Project Officer – David Adams, Zone 1/34, Great Minster House, 33 Horseferry Road, London, SW1P 4DR for clearance before the final invoice is submitted.

19.4 Once agreed with the project officer, the final invoice shall be sent, within 10 days of the end of the month to the period which the claim relates, to: Shared Service Centre, Accounts Payable Team, Sandringham Park, Swansea Vale, Swansea, SA7 0EA.

20. ADDITIONAL INFORMATION

20.1 The Department does not anticipate that Tenderers will be required to make a formal presentation to Departmental officials; nevertheless discussion of the details of the tender may be requested where it is considered that this would be beneficial to the final selection process.

20.2 It is Government policy to treat all contractors fairly and impartially, indeed, tenderers are encouraged to ask questions and so ensure full understanding of the requirement.

21. LOCATION

21.1 All impact tests shall be carried out at the contractors premises unless by prior agreement with the project officer. However, Tenderers should state whether they are able to provide the requirements set out in this document at more than one location, either in the UK or elsewhere.

22. ANNEX A

Test equipment

22.1 The following test equipment is owned by the Department for Transport and will be provided to the successful test laboratory for the duration of this contract.

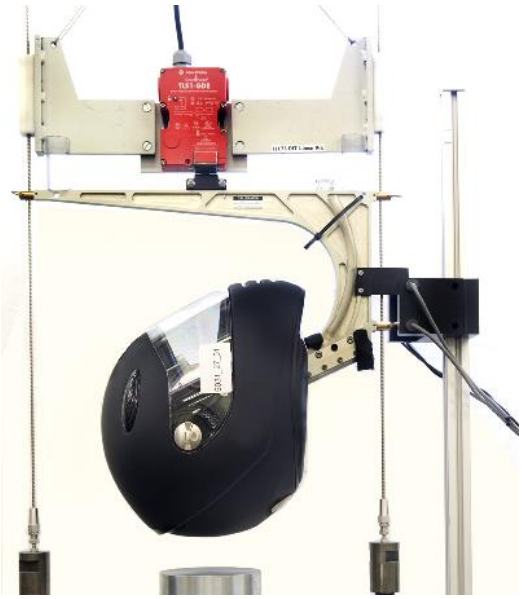
- ¾ head forms – sizes A, E, J, M & O (for linear impact tests)
- Supporting arm for linear impacts to the crown impact test point
- Cantilever supporting arm for linear impacts to all other impact test points
- Control carriage (to hoist the falling assemblies).
- Accelerometer (Kistler 8763A 1000 Ceramic Shear Accelerometer)
- Hemispherical striker for pre test equipment checks

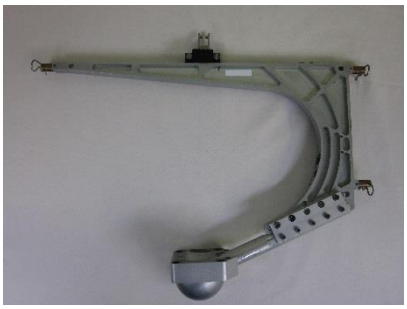
All other test equipment shall be provided by the contracted test laboratory.

22.2 Linear Impact Test Apparatus

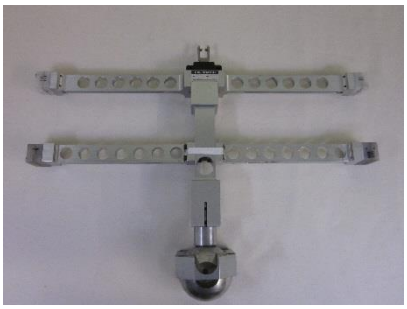
For linear impacts, a “twin wire” guided test apparatus will be required that meets the requirements set out in British Standard (BS) 6658:1985 but modified from the requirements of that standard in the following areas:

- The twin guide wires shall be stainless steel and of stranded construction, 4mm in diameter and nominally positioned 455 mm apart.
- The tension in the twin guide wires shall be maintained at not less than 1.5kN for each impact test.
- The twin guide wires shall be secured at their upper end - so the effective length is maintained to a minimum for each impact velocity used in the test programme.
- The test apparatus shall have the capacity to test helmets at impact velocities of up to 10m/s.
- The control carriage shall be able to lift, hold and release the supporting arm assembly from the required height. This carriage, with a supporting arm and linear impact head form, shall be capable of being positioned and held securely at any point along the length of the twin wire guides of the test apparatus.
- The supporting arms have a mounting ball designed for use with the linear impact head forms and are therefore compatible with the head form socket. The two supporting arms permit a helmet to be impacted at each of the sites B, P, R and X, specified in UN ECE Regulation 22.05, without the need to modify the helmet in any way (i.e. cutting away the chin guard in part or in whole). The supporting arm and mounting ball is designed to accommodate the tri-axial accelerometer.





Supporting arm - impact points B, X & R



Supporting arm - impact point P

- The mass of the supporting arm and mounting ball is distributed such that, as far as is practicable, the supporting arm assembly maintains its horizontal (x and y plane) orientation, i.e. so that rotation and translation of the arm during guided fall is minimised.
- The supporting arm is designed and engineered so that the centre of gravity of the assembly of the supporting arm, the mounting ball and required peripherals (e.g. clamps and retaining bolts), the accelerometer and each three quarter head form lie within a cone of 10 deg. Included angle, having a vertical central axis and its vertex at the point of impact.
- Under all circumstances the combined mass of the supporting arm assembly and each linear impact head form satisfies the head form mass requirement as specified below.
- When in guided free fall, the intended point of contact of any helmet being tested against an anvil placed below the apparatus shall be in vertical alignment with the centre of gravity of the equipment.
- Impacts are performed onto both flat and kerbstone anvils as defined in UN ECE Regulation 22.05.
- Three quarter head forms of size code A, E, J, M and O and of appropriate geometry as specified in ISO DIS 6220:1983 and EN 960:1994 shall be used.
- The falling mass of each size of test head form, supporting arm, accelerometer and required peripherals (e.g. clamps and retaining bolts) shall be as follows; size A - 3.1kg, E - 4.1kg, J - 4.7kg, M - 5.6kg and O - 6.1kg. Each assembly shall have a mass tolerance not exceeding +/- 0.1 kg and the mass of the supporting assembly shall not exceed 20% of the total mass of the drop assembly.

22.3 Oblique Impact test apparatus.

Oblique impact testing requires the use of the “method a” test apparatus and procedure as prescribed in UN ECE Regulation 22.05.

22.4 Oblique impact anvil.

The anvil shall be mounted securely at an angle of 15° to the vertical with provision for fore-and-aft adjustment. The anvil shall have a minimum width of 200 mm and be adaptable to carry an abrasive surface.

The abrasive surface shall be established by the use of a sheet of grade 80 closed-coat aluminium oxide abrasive paper with a minimum supported length of 225 mm securely clamped to the base of the anvil to prevent slippage.

The anvil shall be used to assess the tangential forces caused by friction against the outer surface of the helmet. The anvil shall be fitted with force transducer(s) connected to recording apparatus such that the transmitted longitudinal force component can be measured and continuously recorded with an accuracy of ±5 per cent during a glancing blow to any part of its exposed surface.

22.5 Instrumentation.

A tri-axial accelerometer shall be housed in the ball of each supporting arm assembly with the z axis aligned within 1 degree of the vertical plane and the x axis passing through the plane joining the guide wires. The three axes are mutually perpendicular. The accelerometer is able to measure acceleration of the head form in both the vertical and horizontal directions. The accelerometer is capable of operating in the range of 1 to 1000g and withstanding a 2000g shock without damage.

A load cell shall be installed in the anvil mounting of the linear impact equipment. The load cell shall have a measuring range of 0 to 200kN. The charge meter shall have a full scale measuring range of ±2 to 2200000 pC and a frequency range of ≈ 0 to 200kHz.

A three axis load cell shall be mounted in the anvil of the oblique impact equipment. The load cell shall have a measuring range of -20 to +20kN in F_X & F_Y and -10 to +40kN in F_Z. The charge amplifier has a full scale measuring range of ±200 to 200,000 pC and a frequency range of ≈ 0 to >45kHz.

A velocity meter shall be installed to measure the velocity of the drop assembly at a point not exceeding 60mm above the anvil contact point.

22.6 Data acquisition

Test data shall be acquired and managed in accordance with SAE J211;2003 (Channel Filter Class 1000). Time history shall be recorded at a minimum of 16kHz for both linear and oblique impacts.

22.7 Equipment Checks/Calibration

Pre-test checks shall be conducted in accordance with the requirements of section 2.3. The periodic calibration of equipment shall be:

Tri-axial accelerometer and power supply unit/coupler	12 months
Load cell and charge coupler	12 months
Three axis load cell and charge amplifier	24 months
Velocity meter	12 months

Measuring instruments shall be calibrated at the frequencies set out above or as specified by the manufacturer if the period is shorter.

Test procedures

22.8 Pre-test storage, conditioning and marking of helmets.

Each helmet shall be exposed to a temperature of 25 °C ± 5 °C for at least 4 hours prior to testing and shall not be exposed to direct sunlight or any other heat source prior to, or during, testing. Each helmet shall be weighed and a measurement made of the internal circumference and external shell size. A photograph of a sample of each model shall be taken and a non-destructive assessment made of the external projections which shall be noted and photographed.

The impact points shall be marked on the external surface of the helmets using apparatus capable of providing accurate and repeatable results. It is expected that contractors will use a jig with laser sighting or similar equipment to fulfil this requirement. Before conditioning, each helmet shall be marked with impact points B,X, P and R in accordance with the requirements of Section 7.3.1.2 of UN-ECE Regulation 22.05.

22.9 Impact location.

Where, as a result of the mark-up procedure, it is clear that a direct anvil strike, normal to the tangential plane of the impact point cannot be achieved, perhaps because of helmet contours, aerodynamic features etc., an alternative impact site may be selected, or the obstruction managed in an alternative way. The contractor shall be required to discuss the use of alternative test sites with the project officer before testing commences.

22.10 Pre-test equipment checks.

Test equipment shall be checked at the beginning of each day's testing and repeated if the number of individual impacts exceeds 75 in a single day or, if the supporting arm is changed.

Checks shall be carried out to confirm the correct orientation of the tri-axial accelerometer, the operation of the data recording system and correct functioning of the mechanical components using a striker having a spherical profile below the horizontal plane when installed on the supporting arm. This striker is machined so that it can be attached to the supporting arm using the ball and socket arrangement when installed and ready for use with the prescribed test head forms. The tri-axial accelerometer is aligned in accordance with section 1.5.

When mounted on the supporting arm, the striker is impacted onto a Modular Elastomer Programmer (MEP) test piece. The MEP shall be 152mm in diameter and 25mm thick, having 63 Shore A hardness. The MEP shall be mounted on a 6.35mm thick aluminium plate and centred on the vertical axis of the accelerometer ensuring that the striker impacts at this position.

For the purposes of checking, the effective length of the twin wires is controlled in accordance with paragraph 2.5 for an impact velocity of 6.0m/s. Two drop heights are

established from which notional acceleration values at impact of 175g and 300g are achieved.

The checks shall be performed by dropping the striker and supporting arm assembly five times from each reference height to check that the acceleration values are recorded within the prescribed range. The data from the last three of these drops are reviewed; at least 95% of the resultant acceleration determined from the X, Y and Z values measured by the tri-axial accelerometer must be in the z-axis for the check to be valid. The decelerations recorded in the z-axis by the tri-axial accelerometer must be within ± 5% at each of the target values. The velocity immediately prior to impact and the measured deceleration values are recorded.

22.11 Linear impacts.

Impact energy absorption is determined by recording against time the acceleration imparted to a head form fitted with the helmet, when dropped in guided free fall at a specific impact velocity upon a fixed steel anvil.

For each model of helmet that is rated, the SHARP linear impact assessment comprises 30 individual impacts, 5 applied to each of 6 helmet samples.

The impacts to each helmet follow the sequence of Front (Position B), Side Left (Position X_L), Side Right (Position X_R), Rear (Position R) and Crown (Position P). All of the impacts on an individual helmet shall be against the same anvil type (either the flat or the kerb anvil). Each size of helmet tested is subject to tests on both the flat and the kerb anvil.

The impact tests are conducted at:

- 6.0 m/s using a head form size J,
- 7.5 m/s using a head form size O, and
- 8.5 m/s using a head form size M.

The tolerance for the impact velocity is -0/+0.15m/s. At least 95% of the resultant acceleration calculated from the output of the tri-axial accelerometer must be in the z-axis for the test to be valid. In the case that either parameter fails to satisfy the respective tolerance the whole test for that helmet sample will be deemed invalid.

By exception, where it is not possible to select a helmet from the model range that fits the required head form correctly, a smaller or larger head form may be used. In this case the impact velocity shall be adjusted to maintain equivalent impact energy with that of the standard configuration.

All impacts shall be within a 10 mm radius of the defined points: B, X_L, X_R, R and P.

When conducting the kerb impact tests the orientation of the kerb edge is parallel to the XX' plane at points B, P, and R, and parallel to the AA' plane at point X.

22.12 Procedure.

The tension in the twin guide wires shall be controlled by the application of a tensile force of not less than 1.5kN. Each of the twin guide wires of the test apparatus shall be rigidly secured as close as possible, but in no case more than 750mm above the height of the supporting arm assembly when in its holding position prior to release.

The test head form shall be so positioned that the impact point on the helmet, when correctly positioned on the headform, is vertically above the centre of the anvil. The plane tangential to the point of impact on the helmet's outer surface shall be horizontal. The use of auxiliary retention devices (e.g. Velcro straps) between the chin strap, and the supporting arm are likely to be necessary to maintain the helmet in its correct position on the headform during free fall. Tenderers should indicate how they would ensure the accuracy of the headform position and secure the helmet to the headform.

22.13 Oblique impacts

The procedure is that defined as Method A (abrasive anvil), in UN ECE Regulation 22.05. paragraph 7.4.1. The impact velocity (in the vertical plane) for these tests shall be 8.5m/s (-0/+0.15m/s).

It is recognised that the method for supporting the helmet whilst in free fall is not clearly defined and tenderers are therefore invited to detail how this will be achieved and to provide evidence that the chosen method can provide good repeatability and does not have a negative effect on the magnitude of the result.

<u>Data collection</u>

22.14 Linear impact data.

Following a linear impact test sufficient data shall be recorded digitally to provide the measured impact velocity, the anvil force / time loadings and a complete head form acceleration / time history in each of the three axes of the head form accelerometer. These data are processed to provide:

- values for linear acceleration in the X, Y and Z directions;
- calculation of the vertical resultant (R) of the drop assembly;
- the period where head form acceleration is greater than 150g (ms);
- the time duration to peak acceleration (ms);
- the Head Injury Criterion.

These data shall be supplemented by force/time data from the impact anvil load cell and all data shall be recorded in individual MS Excel files for each impact.

22.15 Face guard locking mechanism (System (flip front) helmets).

After each linear impact test the helmet shall be inspected to determine whether the locking mechanism has remained fully effective. Instances of any failure of the mechanism to keep the face guard fully locked shall be recorded on a template provided by the Department.

22.16 Oblique impact data.

Following an oblique impact test sufficient data shall be recorded digitally to provide the measured impact velocity and complete longitudinal, lateral and normal force / time histories.

These data are processed to provide the:

- peak longitudinal force;
- peak lateral force;
- peak normal force;
- anvil resultant force.

Data shall be exported into MS Excel files for each of the two oblique impact tests.

22.17 Data summary sheet:

Sample / File	Head Form	Position	Anvil	Velocity	Actual Velocity	Impact Energy	Vertical / Resultant %	Vertical Acceleration 'Z'	Vertical Acceleration 'R'	Time >150g	Time to max g	HIC
	J	Front	Flat	6								
		Left										
		Right										
		Rear										
		Crown										
	J	Front	Kerb	6								
		Left										
		Right										
		Rear										
		Crown										
	M	Front	Flat	8.5								
		Left										
		Right										
		Rear										
		Crown										
	M	Front	Kerb	8.5								
		Left										
		Right										
		Rear										
		Crown										
	O	Front	Flat	7.5								
		Left										
		Right										
		Rear										
		Crown										
	O	Front	Kerb	7.5								
		Left										
		Right										
		Rear										
		Crown										

Sample / File	Head Form	Size	Position	Anvil	Target Velocity	Measured Velocity	Longitudinal Force (N)	Integral (Ns)	Normal Force (N)	Lateral Force (N)	Resultant Force (N)
	J		Side L	Abrasive	8.5						
	J		Side R	Abrasive	8.5						