Table 14 – Design Scenarios and Application of Anthropometric Data (Peebles & Norris, 1998)

Design Scenario	Aim	Example	Design Should Accommodate:	Critical Design Scenarios:
Fit	Design to ensure user-product match and appropriate and effective use	Bicycles, cycle, helmets, car restraints, seats	Maximum range of population, e.g. 5th to 95th %ile	Use both maximum and minimum expected values
Reach	Placement to ensure access and appropriate and effective use	Position of handrails and controls	Smallest of population, e.g. 5th %ile	Use minimum expected value
Clearance	Placement to avoid undesirable or unintentional contact	Access hatches, desk seat gaps	Largest of the population, e.g. 95th %ile	Use maximum expected value
Posture	Design to ensure comfortable and safe posture is adopted	Working surface height, position of VDU	Maximum range of population, e.g. 5th to 95th %ile	Use maximum and minimum expected values
Strength	Design to ensure operability	Bottle tops, jar lids, machine controls	Smallest of population, e.g. 5th %ile	Use minimum expected value
Entrapment	Avoid unintentional snagging and retention of the whole body or body parts	Railings, washing machines, ladders, banisters	Largest of the population, e.g. 95th %ile	Use maximum expected value
Exclusion	Ensure safety is maintained by preventing users from gaining access to unsafe areas	Barriers, railings, guards	Maximum range of the population, e.g. 5th %ile female to 95th %ile male	Use maximum and minimum expected values

The output of the requirements analysis phase is normally a set of design guidance and subsystem requirements based on the SRD and any other context documentation that has been provided with the contract. The exact nature of the design guidance generated will vary between contracts and domains. Within platform design (such as land vehicles, ships and aircraft) anthropometric data will initially be used in the specification of crewspace and in the design of the equipment components.

In the maritime domain, MAP 01-107, Parts 1 & 2 (Ministry of Defence, 2009) outlines key responsibilities for the platform provider concerning the development of anthropometric design guidance and accommodation policies. Similar guidance may be envisaged in other domains. In the land domain the combination of anthropometric requirements accompanied by a TAD, postural requirements and clearances, will enable the HF professional to establish the "Critical Build Lines" for the accommodation of the user in the platform. The critical build lines are the volumetric requirements of the user that inform the occupant packing in a platform. Figure 28 shows these, and typical postural requirements[2], for an Armoured Vehicle driver.

[2] Typical driver postural requirements are taken from Defence Standard 00-250, Part 13, Figure 13.11 - Anthropometric Considerations in Designing Seats for Automobile Drivers, Page 246, further postural guidance will be provided in TG4.1 "Working and Living Spaces" when available

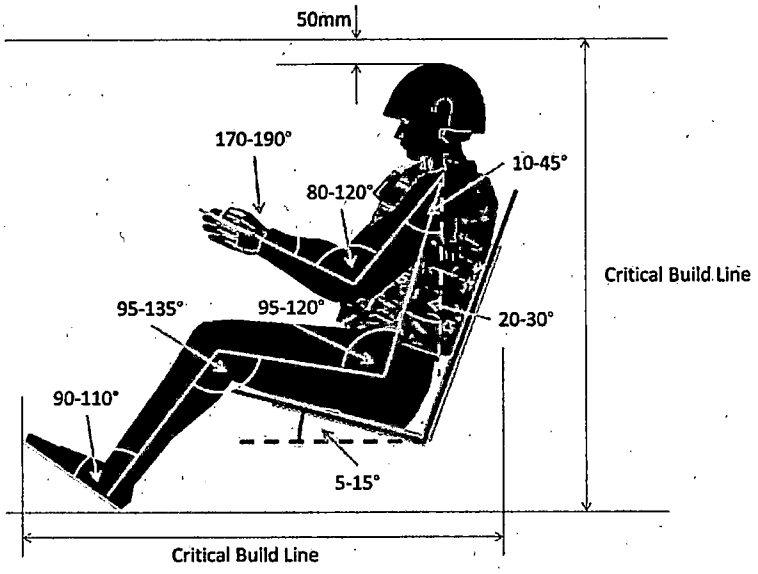

Figure 28 – Typical Driver Critical Build Lines (Cummings, et al., 2015)

The critical build lines for a solution will vary between contracts dependent upon the tasks that the user performs in order to deliver the capability required. For example, occupant packing in fast jet cockpits will require a different posture to that illustrated above for a typical vehicle driver. Within aircraft design contracts, anthropometric data may be used to generate critical build lines around the design eye position and over the nose vision requirements as well as ejection envelope requirements. These typical considerations are illustrated below in Figure 29.

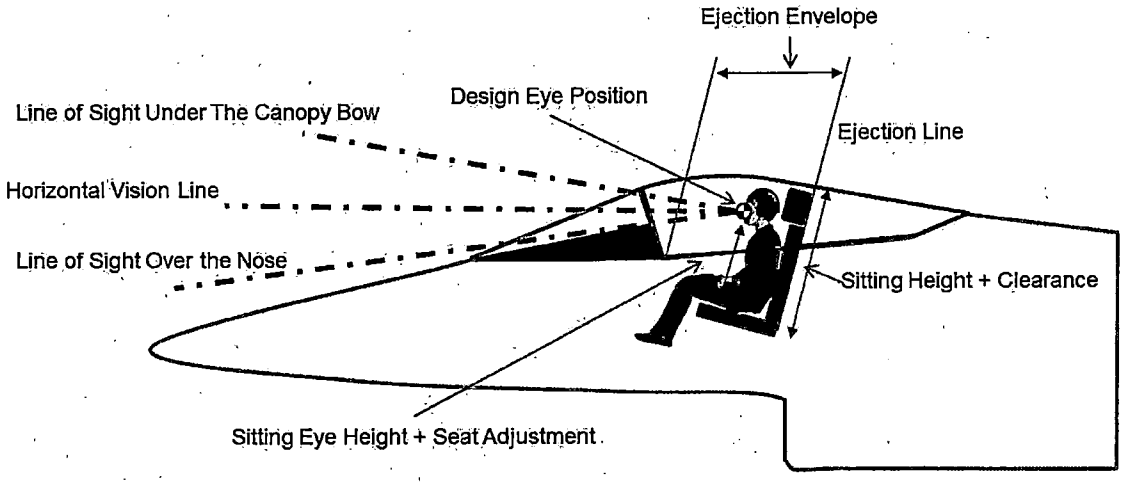

Figure 29 – Some Anthropometric Considerations in a Fast Jet Cockpit

Occupant packaging in platforms is only one example of the use of anthropometric data in design. Anthropometrics will also be used to determine clothing sizing policies and in the design of a wide range of equipment. Anthropometric data should be used to inform the design of any piece of equipment or component that a user will have to interact with in some way. An understanding of the context of use is needed for the designer to identify the specific anthropometric data required to develop the design solution.

The initial requirements analysis activity may take place during the Assessment phase. However, it should be revisited post contract award and periodically through the Demonstration phase. The requirements analysis activity must be linked closely with the wider HFI effort through the record of

assumptions, issues and risks in the RAIDO or HFI Considerations Register. Early in the acquisition process, assumptions may have to be made concerning the volume of crewstation components and attributes of seating. Seating characteristics that affect accommodation include seat pad compression, seat stroke[3] and seat adjustment ranges; these may all form the basis of subsystem requirements, which the Solution Provider will place on their seating supplier. Any assumptions made should be validated as the design process progresses and subsystem suppliers are down-selected.

11.2 DESIGN ASSESSMENT

Early and continued design influence is critical to the integration of anthropometric requirements in the design of any system. Although the design requirements may have been set through the requirements analysis phase, the HFIM must continually monitor the developing design to ensure that anthropometric requirements are not compromised in the realisation of the solution design.

The designer must be aware of the five fundamental fallacies defined in Pheasant & Haslegrave, (2005). These are defined below as assumptions that must be avoided in design.

Design Best Practice Note 35:
Five fundamental fallacies in design are:

1. The design is satisfactory for me – it will therefore be satisfactory for everybody else;
2. The design is satisfactory for the average person – it will therefore be satisfactory for everyone else;
3. The variability of people is so great that they cannot possibly be catered for in any design – but since people are wonderfully adaptable it doesn't matter anyway;
4. Ergonomics (or Human Factors Engineering) is expensive and since products are actually purchased on appearance, styling and engineering capability, ergonomic consideration may be conveniently ignored;
5. Ergonomics is an excellent idea. I always design things with ergonomics in mind – but I do it intuitively and rely on common sense so I don't need experimental studies or tables of data.

DHM tools and physical mock-ups play a significant role in the ability of the HFIM to monitor and assess design progress and compliance. The task analysis provides the HFIM with a useful reference to monitor anthropometric requirement compliance, and to identify particular areas of anthropometric risk in the design.

[3] Seat Stroke is the vertical length of travel of a seat (note mine protected seating may travel 150mm or more when subjected to a blast event.)

Case Study: Availability of Representative Equipment for Testing

During the development of the F-35 an issue was identified with the positioning of a rotary control in the central console of the cockpit, late in the assessment process. Although the cockpit had been developed using numerous geometry and layout assessments; a representative control had not been available for testing. It had not been appreciated that the pilot's knee would rub against the control causing its setting to change. This resulted in the need for a late design change to mitigate the issue.

Lessons Learned:

1. *Availability and fidelity of system components available for testing may have a significant impact on the validity of results gained from mock up testing.*
2. *Multivariate anthropometric issues may arise in unforeseen areas.*
3. *Early testing can save costly redesign late in the development process.*
4. *The build standard of mock-ups must be recorded and maintained to ensure that test results can be compared and an accurate record of what has been tested maintained.*

During design optimisation it may be necessary to trade some requirements. If it is deemed necessary to trade an anthropometric requirement, the HFIM shall quantify and justify the non-compliance.

11.3 REQUIREMENTS ASSURANCE

As the design matures, anthropometric assurance evidence should be generated in accordance with the agreed verification codes and SRLs. Early in the design phase, anthropometric assurance may be limited to the design inspections and review of specifications. As the design matures, assurance may be provided through virtual testing using DHM and Virtual Reality systems to test the design solution.

The final stages of assurance should be provided through the physical testing of mock-ups, prototype equipment and ultimately the design solution. The HFIM should ensure that test evidence is provided to the Acquirer at the HFI Working Group and design reviews to monitor compliance against the anthropometric requirements.

APPENDIX A TERMINOLOGY

A.1 ACRONYMS & ABBREVIATIONS

Acronym	Definition
%ile	Percentile
ANSUR	Anthropometric Survey
APC	Armoured Personnel Carrier
BFM	Battlefield Mission
CAD	Computer Aided Design
CAESAR	Civilian American and European Surface Anthropometry Resource
CBRN	Chemical, Biological, Radiological & Nuclear
CIWG	Capability Integration Working Group
CONEMP	Concept of Employment
CONUSE	Concept of Use
COTS	Commercial Off The Shelf
CS95	Combat Soldier 95
DE&S	Defence Equipment & Support
DHCSTC	Defence Human Capability Science and Technology Centre
DHM	Digital Human Modelling
DIS	Draft International Standard
Dstl	Defence Science and Technology Laboratory
DTEP	Detailed Test Evaluation Plan
ECW	Extreme Cold Weather
EHFA	Early Human Factors Analysis
EPA	Environmental Protection Act
FLC	Front Line Command
FM	Female
FV	Fighting Vehicle
GSA	Generic Soldier Architecture
HCD	Human Centred Design
HD	Horizontal Distance
HF	Human Factors
HFI	Human Factors Integration
HFICR	Human Factors Integration Considerations Register

Acronym	Definition
HFIF	Human Factors Integration Focus
HFIM	Human Factors Integration Manager
HFIP	Human Factors Integration Plan
HFIWG	Human Factors Integration Working Group
HFSR	Human Factors System Requirements
HMNVS	Head-Mounted Night Vision System
HSWA	Health and Safety at Work Act
HTA	Hierarchical Task Analysis
IPE	Individual Protective Equipment
ISO	International Standards Organisation
ITEAP	Integrated Test Evaluation and Acceptance Plan
KiD	Knowledge in Defence
KSR	Key System Requirement
KUR	Key User Requirement
M	Male
Mk	Mark
MOD	Ministry of Defence
MOLLE	Modular Lightweight Load-carrying Equipment
MoP	Measure of Performance
MOTS	Modified Off The Shelf
MTP	Multi Terrain Pattern
NVG	Night Vision Goggles
NVS	Night Vision System
OTS	Off The Shelf
PCA	Principal Component Analysis
PCS	Personal Clothing System
PECOC	Personal Equipment Common Operating Clothing
PIHP	Personal Interfaced Hearing Protection
PPE	Personal Protective Equipment
PRR	Personal Role Radio
PT	Project Team
RAC	Royal Armoured Corps
RAF	Royal Air Force
RAIDO	Risks, Assumptions, Issues, Dependencies, Opportunities
REBA	Rapid Entire Body Assessment

Acronym	Definition
Ref	Reference
RM	Royal Marines
RN	Royal Navy
RULA	Rapid Upper Limb Assessment
RWG	Requirements Working Group
SIG	Swiss Industrial Company
SMART	Specific Measurable Achievable Realistic Time-Related
SME	Subject Matter Expert
SoR	Statement of Requirement
SRD	System Requirements Document
SRL	System Readiness Level
SRP	Seat Reference Point
SRV	Seat Reference Vertical
T&E	Test & Evaluation
TAD	Target Audience Description
TDP	Technology Demonstrator Programme
TG	Technical Guide
UBACS	Under Body Armour Combat Shirt
UGL	Under-Slung Grenade Launcher
UK	United Kingdom
UOR	Urgent Operational Requirement
UR	User Requirements
URD	User Requirements Document
USAF	United States Air Force
V&V	Validation & Verification
WBS	Work Breakdown Structure
ZCR	Zones of Convenient Reach

A.2 GLOSSARY OF TERMS

Term	Definition
Acquirer	The stakeholder that acquires or procures a solution from a supplier.
Anthropometry	The branch of science that deals with the measurement of the human body
Anthropometrics	Term used for the application of body size and movement data
Candidate Requirement	A requirement that may be included in an SRD but needs to be tailored.
Cervicale	Body landmark – The prominence on the seventh or lowest cervical vertebra at the back of the neck
Context of Use	Users, tasks, equipment (hardware, software and materials), and the physical and social environments in which a system is used.
Ergonomics	Synonymous with Human Factors
Human Centred Design	An approach to design that is characterised by the active involvement of users, a clear understanding of user and task requirements, an allocation of function between users and technology, iterations of design solutions, and multi-disciplinary design.
Human Factors	Study of human capabilities and limitations, human interactions with technologies and environments, and the application of this knowledge to products, processes and environments.
Human Factors Integration	A systematic process for identifying, tracking and resolving human related issues ensuring a balanced development of both technologies and human aspects of capability.
Requirement	A statement of need that is to be satisfied under the contract.
Seat Reference Point	The midpoint of the intersection of the plane of the seat surface with the plane of the backrest surface of the seat, and tangents of the mid-line contours of the seated person.
Solution	The output that results from the contract between the Acquirer and the Supplier.
Solution Provider	An organisation or an individual that enters into an agreement with the Acquirer for the supply of a solution.
Target Audience Description	A detailed description of the physical, psychological and sociological characteristics and organisation of the types and groups of people that will operate, support, sustain and maintain the Solution together with supporting data.
Usability	Extent to which a solution can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use.
Validation	Confirmation, through the provision of objective evidence, that the requirements for a specific intended use or application have been fulfilled.
Verification	Confirmation, through the provision of objective evidence, that specific requirements have been fulfilled.
VIRTUS	UK Defence programme established to deliver future protection and load carriage systems for the dismounted soldier
Zone of Convenient Reach	Reach zone driven my functional reach from the shoulder used to position objects in arm's length.

APPENDIX B CASE STUDIES

B.1 Understanding the Constraints of Legacy Systems

B.1.1 Reference Concepts Detail

The use of Reference Concepts and Technology Demonstrator Programmes (TDPs) in the MOD proved useful during requirements development for the Future Rapid Effect System, Utility Vehicle (FRES UV) and the Medium Armour Tracks Team, Specialist Vehicle (MATT SV). It enabled the PT to determine what was possible when developing the requirements for FRES UV and SV Scout, both of which relied on the use of Modified Off The Shelf (MOTS) vehicle hulls. Reference Concepts can be particularly important when considering the full requirements set, and for identifying areas where trades may be required between requirements.

The use of reference concepts enabled the identification of minimum roof height requirements for the ambulance and personnel carrying variants, using crew and passenger task-based assessments in a Digital Human Modelling tool and subsequent mock-up trials to further develop the requirements for internal roof height.

B.1.2 Reference Concepts Lessons Learned

1. Where an acquisition is based on the constraints of a legacy or Off The Shelf (OTS) platform, the generation of reference concepts provides a useful means of understanding the feasibility of meeting the requirements and identifying areas where requirements trades may need to be considered later in the acquisition process.

B.2 Use of Digital Human Modelling in Design and Assurance

B.2.1 Digital Human Modelling Detail

During the development of Scout SV Digital Human Modelling was used extensively to de-risk elements of the system design. Anthropometric fit, crew posture and emergency egress were all identified as programme risks during the EHFA. Therefore DHM was used extensively to de-risk the developing design solution, prior to a vehicle mock-up being available for testing. DHM proved useful in identifying issues and optimising design solutions, but could not fully replace the need for development tests using mock-ups.

B.2.2 Digital Human Modelling Lessons Learned

1. DHM enabled design solutions that would definitely not meet the requirements set to be rapidly dismissed prior to committing to building mock-ups.
2. Although modern DHM tools are very powerful, they do not currently do away with the need for mock up testing, particularly for time-based requirements such as emergency egress.
3. Mock-ups provided a useful means of validating the DHM modelling, particularly when considering the postures adopted by vehicle crewman.

B.2.3 Digital Human Modelling in Driver Head Out Vision Detail

During the development of the driver's crewstation in an armoured vehicle contract, additional manikins had to be generated to assess head-out driving. Assessment of the task identified that the worst case would be a large female of short stature, as the low female sitting eye height, combined with a large thigh thickness and large chest depth would have the greatest influence on the operability of controls and driver vision while operating in this position.

A manikin was therefore generated for assessing head-out driver vision, where thigh thickness under the steering device and chest depth to the front of the hatch aperture placed additional constraints on the eye position, informing the adjustability of seating and the positioning of driver's controls.

B.2.4 Lessons Learned

1. Assessing only the extremes of the population on a univariate basis may not identify problematic anthropometric attributes.
2. All testing whether virtual (through DHM) or physical (through the use of mock-ups and prototypes) must assess the full breadth of the target audience to ensure that issues are identified and mitigated early in the design process.

B.3 Seat Design

B.3.1 Seat Design - Introduction

The Defence Human Capability Science and Technology Centre Task Identification Number 3.118 "Percentile Limits Review" final report (Cummings, et al., 2015) noted particular problems with complying with anthropometric requirements in 2nd and 3rd tier suppliers. Seating providers do not always employ HF professionals in the development of seating and therefore some issues were identified with the interpretation of the anthropometric range requirement.

Early seating designs were developed using the 5th and 95th percentile manikins and took no account of other users within the anthropometric range. Therefore, a seat design was generated that contained no intermediate positions in the adjustment of the seat pan horizontally or the footrest vertically. (Cummings, et al., 2015) disaccomodating or compromising the posture of a majority of the target audience.

B.3.2 Seat Design Lessons Learned

1. Assessing only the extremes of the population on a univariate basis may not identify problematic anthropometric attributes.
2. All testing whether virtual (through DHM) or physical (through the use of mock-ups and prototypes) must assess the full breadth of the target audience to ensure that issues are identified and mitigated early in the design process.

B.4 Changes to Clothing and Equipment Ensembles Once In-Service

B.4.1 Titan Bridge Laying Vehicle Detail

The Titan Bridge Layer was designed in accordance with a TAD which included Enhanced Combat Body Armour and cold weather clothing. During the acceptance process the vehicle was tested using these clothing configurations and passed its requirement acceptance tests. However, once in service, the introduction of Osprey Body Armour presented major issues for vehicle crews as they entered and exited the vehicle. The ingress route into the Driver's crewstation is up the front glacis plate and underneath the bridge laying equipment mounted on the front of the vehicle. The gap under the bridge laying equipment will accommodate the nude chest depth of the user population with some allowance for cold weather and CBRN clothing; however, changes to the body armour policy and the use of Osprey body armour by Armoured Vehicle crews mean that few vehicle crews can safely fit under the bridging equipment. This has led to crews having to remove their body armour during egress or having revert to earlier body armour configurations to prevent becoming stuck under the bridging equipment (particularly during egress). (Cummings & Launchbury, 2014).

Figure 30 Titan Driver Egress Route (Cummings, et al., 2015)

B.4.2 Lessons Learned

1. Changes in the 'wider system' must be monitored through-life and where possible predicted at the requirements stage to prevent a decrement to performance through life.
2. If a change to any element of the system design is made, the impact of this change must be assessed to ensure that it does not have an effect on the capability as a whole.
3. Although the introduction of more capable body armour should enhance crew safety, the impact that it had on crew egress presented a safety hazard to vehicle crews.
4. The impact of a change may not affect all tasks equally. For example, while crews could still ingress the vehicle, egress was a greater risk as the armour snagged and rode up during this process.

B.5 Percentiles, Multiple Dimensions, Functions and Tasks

B.5.1 Restraint Harnesses Detail

A bulletin from the Air Accident Investigation Bureau describes an incident which illustrates the issue of multiple, interacting critical dimensions and the impact of the implementation of locking restraint harnesses on pilot reach within an aircraft cockpit (Air Accident Investigation Bureau, 1993).

An aircraft was indicating problems with hydraulics and landing gear, and emergency landing procedures were initiated. This required locking of seat harnesses. When the commander asked the first officer to select reverse thrust during the landing, "the first officer was unable to depress the reverse gate and retard the throttles with her left hand and with her seat harness locked; she was unable to use her right hand". In addition, the first officer was unable to reach the master electrical switch when harness was locked as these were placed some 60mm beyond the reach of the fingertips of a fully extended left arm. Fortunately, in this incident nobody died, and there were no injuries, however things could easily have been different.

An investigation into the incident identified that while a number of the controls were within reach of the first officer, they could not be operated as the user could not move their torso and therefore could not apply the necessary force within the posture to change the state of the switches, particularly those that had been positioned in an overhead panel.

B.5.2 Restraint Harnesses Lessons Learned

1. Harnesses have a significant impact on the reach of a user
2. The positioning of controls relative to a user will have a significant impact on their operability (particularly if positioned overhead).
3. Force cannot be applied equally through the full rotation of the shoulder; posture and freedom of movement both a significant effect on the user's ability to complete a task.
4. Just because a control is within reach, this does not mean that the User will be able to operate the switch within all operational conditions.
5. The context of use must account for all conditions of use, including emergency and reversionary modes.
6. Testing must utilise the full range of sizes of users under the conditions identified within the context of use.

B.6 Mock-Up Testing

B.6.1 Testing Using Representative Clothing and Equipment Detail

During the early development of the Hawk Aircraft, mock up testing was used extensively to de-risk the cockpit layout design and ensure that the pilot could perform their tasks within the physical confines of the cockpit. However, early in the mock-up testing phase it became apparent that there were significant differences between trial results concerning the achievable level of stick travel. Fortunately, the design team identified that initial testing had been conducted without inflating the G-suit trousers worn by pilots to prevent blood pooling in the legs during high g manoeuvres. Once the G-suit trousers were inflated the level of achievable stick travel reduced significantly, highlighting an additional constraining factor that initial test had overlooked.

B.6.2 Testing Using Representative Clothing and Equipment Lessons Learned

1. Development testing must be conducted with personnel dressed in appropriate clothing and equipment in order to obtain accurate results.
2. All settings and constraining factors must be identified and recorded within Detailed Test Schedules for requirements testing. Test Schedules must accurately describe all parameters and equipment states for testing to ensure repeatability of testing and results.

B.6.3 Availability of Representative Equipment for Testing Detail

During the development of the F-35 an issue was identified with the positioning of a rotary control in the central console of the cockpit, late in the assessment process. Although the cockpit had been developed using numerous geometry and layout assessments; a representative control had not been available for testing. It had not been appreciated that the pilot's knee would rub against the control causing its setting to change. This resulted in the need for a late design change to mitigate the issue.

B.6.4 Availability of Representative Equipment for Testing Lessons Learned

1. Availability and fidelity of system components available for testing may have a significant impact on the validity of results gained from mock up testing.
2. Multivariate anthropometric issues may arise in unforeseen areas.
3. Early testing can save costly redesign late in the development process.
4. The build standard of mock-ups must be recorded and maintained to ensure that test results can be compared and an accurate record of what has been tested maintained.

APPENDIX C CANDIDATE HUMAN FACTORS REQUIREMENTS

C.1 Anthropometric Candidate Human Factors System Requirements & Compliance Testing

Table 15 – Anthropometric Candidate Human Factors System Requirements & Compliance Testing

Parent 00-251 Reqt.	Number	Candidate Requirement	Suggested Means of Compliance)	Notes and examples
HFSR-1.1	TG1.1 - 001	The System shall accommodate the central [XX] of the anticipated user population in accordance with the Target Audience Description.	Design Inspection. Modelling & Simulation. Development Test. User Trial.	Note 1: The percentage of the population accommodated should be determined by a policy decision. Normal design practice would aim to accommodate 90-95% of the population. The Project team should be prepared to justify the percentage of the population accommodated. Note 2: Some selection criteria may be required for crews where anthropometric dimensions can be directly traced to a safety critical aspect of the design. In these instances particular additional requirements may be required if selection criteria are to be avoided. Note 3: The measure of performance for the requirement should include reference to the tasks and functions performed. Separate requirements may also be required concerning the posture that accommodation is tested in. Design Inspection: Design Inspections may be conducted against 2D arrangement drawings or inspection of 3D CAD. Specific accommodation measures should be compared against structural and dynamic anthropometric body dimensions of the specified extremes of the population. Modelling & Simulation: Modelling and simulation activities may include Digital Human Modelling or 3D visualisation of the solution design using Virtual Reality or other visualisation technologies to provide assurance against the design requirement. Modelling and simulation should illustrate the design performance using a range of manikins which reflect the variability of body size as defined in the TAD. Development Test: Development Tests may include mock-ups, simulators and prototype equipment to test the performance of the

Parent 00-251 Reqt.	Number	Candidate Requirement	Suggested Means of Compliance)	Notes and examples
				system. Development tests are particularly useful for assessing the more dynamic aspects of operator tasks. These may include subjective aspects such as comfort as well as time-bound requirements such as emergency egress that are difficult to model effectively. The accommodation requirement should be tested using as many subjects as feasible representing the full range of users defined in the TAD. Testing may need to be conducted in a range of clothing states, not just the maximum clothing bulk. User feedback should be collected through the testing activities and used to inform design. User Trial: These trials may be split into static and dynamic trials to test system performance on the actual equipment. The nature of User trials may vary significantly between acquisitions. Static trials are generally conducted with the equipment in a controlled environment, using a combination of real and virtual inputs to stimulate platform systems. Testing anthropometric requirements will require a combination of static and dynamic trials, while static trials may be required to assess basic anthropometric fit, and postural angles; dynamic trials are also required to ensure that suitable clearances have been provided to maintain comfort whilst completing the BFM. Dynamic trials are conducted with a full system prototype undertaking BFMs in representative environments. Final acceptance will normally be based on the results of dynamic trials and used to verify progressive assurance activities conducted in the development of the solution. Dynamic trials are particularly important in testing anthropometric fit and the effect of platform motion and restraint systems in different operational environments.

HFSR-1.1	TG1.1 - 002	Emergency egress routes (including hatch apertures) shall accommodate Crew and Passengers of body dimensions 1st percentile male to 99th percentile male as defined in the TAD dressed in all clothing assemblies.	Design Inspection. Modelling & Simulation. Development Test. User Trial.	**Note 1:** It is common practice to specify the full anthropometric range in the specification of emergency egress and evacuation routes to ensure that crew and passengers can always escape in case of emergency. **Note 2:** Assessments should be made against all clothing assemblies. Although aperture sizes maybe be driven by the largest Users, it must also be possible for the smallest member of the population to reach critical controls. Also, assessments may need to be considered in a number of orientations; e.g. if a ship has capsized or a vehicle rolled over is it still possible to escape? **Design Inspections:** Apertures and escape routes should be assessed against anthropometric properties such as, maximum chest depth and bideltoid breadth to ensure that crews are able to egress in case of emergencies. Additional equipment may also have to be considered such as breathing apparatus in the design of naval systems. Handles and passageways may also have to be considered in terms of the reach of the smallest members of a crew. **Modelling & Simulation:** DHM may be used to assess the ability of crew and passengers in different clothing ensembles, in large systems such as ships and facilities the flow of personnel may also be simulated in the assessment of Emergency Egress. **Development Test:** Development tests are particularly useful for assessing aspects such as emergency egress. Tests should use an anthropometrically diverse range of subjects to test the performance of the system, however particular focus should be placed on the extremes of the population in this type of testing. . Development tests may involve full scale mock ups and potentially rigs to enable different platform orientations to be tested. **User Trial:** Emergency egress trials will normally be conducted during the static section of system trials. Trials activities should exercise the full anthropometric range of subjects to ensure that the crew and passengers can exit the platform in case of emergency. Particular focus should be placed on the extremes of the population in this type of testing, taking account of all clothing and equipment ensembles that need to be supported.

Parent 00-251 Reqt.	Number	Candidate Requirement	Suggested Means of Compliance)	Notes and examples
HFSR-1.1	TG1.1 - 003	Emergency egress routes (including hatch apertures) shall accommodate Crew and Passengers of body dimensions 1st percentile female to 99th percentile female as defined in the TAD (ANN_G1) dressed in all clothing assemblies.	Design Inspection. Modelling & Simulation. Development Test. User Trial.	**Note 1:** The 99th percentile Female is larger than the 99th percentile Male in certain dimensions (e.g. chest depth), so separate requirements may be required for male and female populations.

HFSR-1.1	TG1.1 - 004	The System shall accommodate Crew and Passengers of body dimensions 5th percentile male to 95th percentile male as defined in a TAD dressed in all clothing assemblies whilst performing all tasks (as defined in the Task Analysis).	Design Inspection. Modelling & Simulation. Development Test. User Trial.	**Note 1:** If there is any scope for trade in the anthropometric fit "Threshold" and "Objective" requirements may be set. For example: "The System shall accommodate Crew and Passengers of body dimensions 5th percentile {Threshold} 3rd percentile {Objective} male to 95th percentile {Threshold} 97th percentile {Objective} male as defined in a TAD dressed in all clothing assemblies whilst performing all tasks (as defined in the Task Analysis)". **Note 2:** The level of accommodation achieved may be used to differentiate between proposed designs by different Solution Providers. **Note 3:** The percentage of the population accommodated should be determined by a policy decision. This may vary between services and acquisition programmes. At the time of writing normal design practice would aim to accommodate 5th -95th percentile in land and maritime systems and 3rd -99th percentile in aircrew systems. The Project team should be prepared to justify the percentage of the population accommodated. **Note 4:** Some selection criteria may be required for crews where anthropometric dimensions can be directly traced to a safety critical aspect of the design. In these instances, particular additional requirements may be required if selection criteria are to be avoided. **Note 5:** The measure of performance for the requirement should include reference to the tasks and functions performed. Separate requirements may also be required concerning the posture that accommodation is tested in. **Design Inspection:** Design Inspections may be conducted against 2D arrangement drawings or inspection of 3D CAD. Specific accommodation measures should be compared against structural and dynamic anthropometric body dimensions of the specified extremes of the population. **Modelling & Simulation:** Modelling and simulation activities may include Digital Human Modelling or 3D visualisation of the solution design using Virtual Reality or other visualisation technologies to provide assurance against the design requirement. Modelling and simulation should illustrate the design performance using a range of

Parent 00-251 Reqt.	Number	Candidate Requirement	Suggested Means of Compliance)	Notes and examples
				manikins which reflect the variability of body size as defined in the TAD. **Development Test:** Development Tests may include mock-ups, simulators and prototype equipment to test the performance of the system. Development tests are particularly useful for assessing the more dynamic aspects of operator tasks. These may include subjective aspects such as comfort as well as time-bounded requirements such as emergency egress that are difficult to model effectively. The accommodation requirement should be tested using as many subjects as feasible, representing the full range of users defined in the TAD. Testing may need to be conducted in a range of clothing states, not just the maximum clothing bulk. User feedback should be collected through the testing activities and used to inform design. **User Trial:** These trials may be split into static and dynamic trials to test system performance on the actual equipment. The nature of User trials may vary significantly between acquisitions. Static trials are generally conducted with the equipment in a controlled environment, using a combination of real and virtual inputs to stimulate platform systems. Testing anthropometric requirements will require a combination of static and dynamic trials, while static trials may be required to assess basic anthropometric fit, and postural angles; dynamic trials are also required to ensure that suitable clearances have been provided to maintain comfort whilst completing the BFM. Dynamic trials are conducted with a full system prototype undertaking BFMs in representative environments. Final acceptance will normally be based on the results of dynamic trials and used to verify progressive assurance activities conducted in the development of the solution. Dynamic trials are particularly important in testing anthropometric fit and the effect of platform motion and restraint systems in different operational environments.

Parent 00-251 Reqt.	Number	Candidate Requirement	Suggested Means of Compliance)	Notes and examples
HFSR-1.1	TG1.1 - 005	The System shall accommodate Crew and Passengers of body dimensions 5th percentile female to 95th percentile female as defined in a TAD dressed in all clothing assemblies whilst performing all tasks (as defined in the Task Analysis)	Design Inspection. Modelling & Simulation. Development Test. User Trial.	**Note 1:** Although generally the female population is smaller than the male, this is not true for all anthropometric dimensions. For example, the female population is larger than the male in terms of hip breadth and chest depth. Therefore, it is advisable to separate male and female requirements.
HFSR-1.1	TG1.1 - 006	The System shall provide the Driver with a crewstation which provides a supported seated posture in accordance with TG1.1 Anthropometry TG Figure 9	Design Inspection. Modelling & Simulation. Development Test. User Trial.	**Note 1:** This is an example requirement specific to the land domain. Additional requirements should be raised for the posture of crew members. Further guidance concerning posture can be found in TG4.1.

APPENDIX D REFERENCES

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APPENDIX E DESIGN BEST PRACTICE NOTES

E.1 Design Best Practice Process Notes

Table 16 presents design best practice process recommendations that could be used as the basis for the generation of design process requirements. Such design requirements would specify 'how' suppliers might undertake detailed technical design processes associated accommodating the physical characteristics of personnel within systems (i.e. anthropometry). Such design process requirements would be complementary to the candidate HF System Requirements contained in Appendix C which describe the anthropometric requirements for the system i.e. the 'what' suppliers are contracted to produce.

It is expected that MoD Requirements Managers would focus their efforts on developing the HF System Requirements leaving industry to adopt best practice in terms of implementing design processes to meet those requirements. The current design best practice process recommendations contained in this appendix are therefore aimed primarily at industry suppliers developing solutions. As good practice evolves these recommendations are also likely to evolve. Means of compliance and notes/examples are also provided.

Table 16 – Design Best Practice Recommendations

Number	Design Best Practice Note	Notes and examples
1	The formula for calculating standard deviation may have a denominator N instead of N-1 only if the measurements represent the whole population, rather than a sample. Using the population formula in small sample sizes underestimates the standard deviation, although the difference may be small.	When 6 individuals or more are measured, the value calculated using N will be greater than 90% of the value obtained using 'N-1'. How the ratio of $\sqrt{(N-1)/N}$ varies with N is illustrated in Figure 2.
2	The first step in design of a workspace shall be to define the "target" population who will use the equipment being designed.	
3	The TAD provides the definition of the anthropometric attributes of the target population, and is therefore one of the key contractual documents concerning anthropometrics	
4	There are some significant differences between UK data and other nations, as well as between Services. Care must therefore be taken to ensure that the correct data set is used in the production of the TAD.	
5	Fitting people into systems is complicated by the length of service of equipment, which may be 50 years, or more.	The Fighting Vehicle (FV) 432 Bulldog APC first entered service in 1963 and in 2014 is still in use. During this time the general population has changed in both size and shape.
6	It is not always possible to provide all the necessary anthropometric data (for example new clothing systems may change clothing additions, or additional dimensions may be required which are not included in the current anthropometric database). In these instances, the Solution Provider should identify and agree the proposed sources of data, or methods of obtaining such data with the Acquirer.	

Number	Design Best Practice Note	Notes and examples
7	In selecting sources of operator population characteristics data, the following order of precedence shall be followed unless the Solution Provider or the Acquirer can demonstrate that more relevant data exist: • Operator characteristics data contained in any TAD issued by the Acquirer. • Operator characteristics data contained in this TG. • Operator characteristics data that can be shown to relate specifically to the expected User population or the population from which UK Defence operator populations are drawn. Operator characteristics data that relate to a more general population.	
8	Data recorded in the Summary tables in Appendix G are nude anthropometric data. Clothing and equipment corrections will need to be applied as appropriate for the capability being procured.	
9	Changes to the TAD post contract award may be costly to both the Solution Provider and the Acquirer.	
10	Changes in clothing and equipment ensembles through life can have a significant impact on crew comfort and safety.	The introduction of new body armour designs for example has had a significant effect on emergency egress and casualty evacuation (CASEVAC) in a number of legacy land platforms.
11	A high-level list of human functions and tasks makes a useful checklist for assessing anthropometric compliance through the course of a development contract.	
12	A Reference Concept is a conceptual representation of the solution (normally a CAD model or physical mock up) developed to understand the feasibility of the requirements set.	
13	The Solution Provider should demonstrate how comfort has been assured in the development of the design solution.	Comfort data should be collected and recorded in the HFI Case in support of the anthropometric compliance statements. Comfort should be managed as a system design risk and therefore be reviewed as an attribute of posture and anthropometric fit. Comfort assurance data may be collected through a variety of methods. Modelling & Simulation: Some DHM tools have comfort assessment modules built into them. Seated comfort assessment methods are particularly well documented in the automotive industry. Comfort may be linked to the provision of good posture during this stage of the assessment. Development Test: Subjective data may be collected through the use of mock up and prototype trials

Number	Design Best Practice Note	Notes and examples
		activities during development tests and used to inform the design process. User Trials: Subjective data may be collected through the use of mock up and prototype trials activities during development tests and used to inform the design process.
14	The Solution Provider should adopt an iterative Human Centred Design process to ensure that operators and maintainers can complete their tasks in accordance with the context of use. Design Best Practice Process Recommendation 3 The Solution Provider should demonstrate that all physical components that constitute workplaces, including platforms, workspaces, work rooms, and workstations, that comprise or are modified by the Solution, have been based on a systematic analysis of: a) Functional needs; b) Context of use; c) Operational conditions of use; d) User clothing and PPE considerations; e) The physiological, psychological and sociological characteristics of the Operator Population, including human error characteristics; f) Human performance shaping factors Human needs.	An iterative Human Centred Design approach is fundamental to the application of HFI in the design of systems. This should be reflected in the Solution Provider's HFIP detailing the schedule of activities and how they inform design. Evidence of trials activities and user involvement should be recorded in the HFI Case and RAIDO including details of issues identified and key decisions made through the course of the programme. Progress against the HFIP should be monitored through the Human Factors Integration Working Group (HFIWG).
15	The Solution Provider should conduct an anthropometric design audit as part of each major programme design review.	The plan of activities should be identified in the Solution Provider's HFIP detailing the schedule of activities and how they inform design. Evidence of trials activities and user involvement should be recorded in the HFI Case and RAIDO including details of issues identified and key decisions made through the course of the programme.
16	Solution Provider should adopt a systematic and iterative approach to the identification and resolution of all anthropometric issues and risks throughout the contract.	The plan of activities should be identified in the Solution Provider's HFIP detailing the Work Breakdown Structure (WBS) schedule of activities and how they inform design. Evidence of trials activities and user involvement should be recorded in the HFI Case and RAIDO including details of issues identified and key decisions made through the course of the programme. Review of HF requirements should be built into the entry criteria for each major design review; this may be achieved through the HFIWG or other working group as required. Any requirement compliance issues should be recorded in the RAIDO or Human Factors Integration Considerations

Number	Design Best Practice Note	Notes and examples
		Register (HFICR) and regularly reviewed through the HFIWG. Mitigation actions should be identified and agreed between the Acquirer and the Solution Provider.
17	The Solution Provider should identify and propose means of demonstrating compliance with each requirement. The Solution Provider shall submit their proposals to the Acquirer for agreement.	Evidence of trials activities and user involvement should be recorded in the HFI Case and RAIDO including details of issues identified and key decisions made through the course of the programme. Review of HF requirements should be built into the entry criteria for each major design review; this may be achieved through the HFIWG or other working group as required. Any requirement compliance issues should be recorded in the RAIDO or HFICR and regularly reviewed through the HFIWG. Mitigation actions should be identified and agreed between the Acquirer and the Solution Provider.
18	The Solution Provider should create and maintain records of requirement trade-off decisions.	The Acquirer and Solution Provider should agree the verification criteria for each HF requirement in the SRD. This process should include the agreement of the progressive assurance activities as well as the final means of acceptance. This should be recorded in the Integrated Test and Acceptance Plan (ITEAP) and HFI Detailed Test Evaluation Plan(s) (DTEP).
19	In selecting sources of operator population characteristics data, the following order of precedence shall be followed unless the Solution Provider or the Acquirer can demonstrate that more relevant data exist: a) Operator characteristics data contained in any target audience description issued by the Acquirer; b) Operator characteristics data contained in TG1.1 "The Anthropometry Technical Guide"; c) Operator characteristics data that can be shown to relate specifically to the expected User population or the population from which UK Defence operator populations are drawn; Operator characteristics data that relate to a more general population.	Potential requirement trade-offs may be identified through the course of design optimisation. These should initially be raised through the HFIWG and raised to the programme Requirements Working Group or Capability Integration Working Group as required. Minutes from each of these meetings should be referenced in the HFI Case and programme RAIDO as necessary.
20	Further information concerning anthropometric body landmarks can be found in The ANSUR II Pilot Study: Methods and Summary Statistics Report (Paquette, et al., 2009).	The plan of activities should be identified in the Solution Provider's HFIP detailing the WBS schedule of activities and how they inform design. Evidence of trials activities and user involvement should be recorded in the HFI Case and RAIDO including details of issues identified and key decisions made through the course of the programme. Review of HF

Number	Design Best Practice Note	Notes and examples
		requirements should be built into the entry criteria for each major design review; this may be achieved through the HFIWG or other working group as required. Any requirement compliance issues should be recorded in the RAIDO or HFICR and regularly reviewed through the HFIWG. Mitigation actions should be identified and agreed between the Acquirer and the Solution Provider.
21	Substantial differences can occur in anthropometric data with the addition of clothes, tools and equipment. An increase in the overall space occupied by a person due to bulky clothing is intuitive, but for overhead reach, for example, there is a decrement in limb movement due to clothing restrictions.	
22	Allowance must be made for the clearance of the operator's gloved or mittened hand if the access is located externally and may require servicing in cold weather conditions.	
23	The dimensions in escape hatch design should be chosen to allow 100% of the population to pass through without impediment.	
24	The VIRTUS programme, formerly PECOC (Personal Equipment and Common Operational Clothing), is intending to deliver an integrated head, torso and load carriage system which should replace Osprey body armour and associated load carriage systems. Once this has been delivered, the details in Table 5 should be updated to reflect the new clothing and equipment ensembles.	
25	Figures within Tables 7 & 8 are intended as a guide only. With the issue of the Combat Soldier 95 (CS95) clothing system, which includes the MK6/6A combat helmets and boots, it is no longer possible to define a single combat ensemble.	
26	Static body dimensions are taken in rigid standardised postures and will not reflect the dynamic nature of many tasks the user will perform	
27	For standing work, controls should be positioned at a height between the shoulder and the elbow and should never be outside the arc described by the arm (upper limb) as it rotates about the shoulder.	
28	Work surface height for medium or light manipulative tasks should be 50-150 mm below elbow level.	
29	The Seat Reference Point should be used to determine the reach dimensions for seated operators when designing the workspace envelope.	
30	The range of adjustability of the crewstation must allow operators of all sizes (as defined in the TAD) to position themselves correctly with respect to crewstation displays and controls.	
31	The system design must accommodate the range of dexterity in the proposed User population (see TG 1.4 "Physical Capabilities").	
32	The system design may have to make allowances for restricted physical abilities (e.g. wounded personnel).	

Number	Design Best Practice Note	Notes and examples
33	The possible movement range of joints varies significantly from person to person. The variation in movement range is illustrated in Table 11, Table 12 and Table 13.	
34	At the time of writing this TG there is ongoing work to generate anthropometric data for the Royal Armoured Corps. This will affect the data included in some of the anthropometric data tables included in Appendix G. The reader should contact Dstl or the DE&S HFI cell for the most up-to-date version of the Tri-Service Anthropometric database.	
35	Five fundamental fallacies in design are: 1. The design is satisfactory for me – it will therefore be satisfactory for everybody else; 2. The design is satisfactory for the average person – it will therefore be satisfactory for everyone else; 3. The variability of people is so great that they cannot possibly be catered for in any design – but since people are wonderfully adaptable it does not matter anyway; 4. Ergonomics (or Human Factors Engineering) is expensive and since products are actually purchased on appearance, styling and engineering capability, ergonomic consideration may be conveniently ignored; 5. Ergonomics is an excellent idea. I always design things with ergonomics in mind – but I do it intuitively and rely on common sense, so I do not need experimental studies or tables of data.	

APPENDIX F PROBABILITIES ASSOCIATED WITH A VALUES OF Z IN A NORMAL DISTRIBUTION

Table 17 – Table of Probabilities Associated with Values of -Z in a Normal Distribution

z	0.09	0.08	0.07	0.06	0.05	0.04	0.03	0.02	0.01	0
–3.4	0.0002	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
–3.3	0.0003	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0005	0.0005	0.0005
–3.2	0.0005	0.0005	0.0005	0.0006	0.0006	0.0006	0.0006	0.0006	0.0007	0.0007
–3.1	0.0007	0.0007	0.0008	0.0008	0.0008	0.0008	0.0009	0.0009	0.0009	0.0010
–3.0	0.0010	0.0010	0.0011	0.0011	0.0011	0.0012	0.0012	0.0013	0.0013	0.0013
–2.9	0.0014	0.0014	0.0015	0.0015	0.0016	0.0016	0.0017	0.0018	0.0018	0.0019
–2.8	0.0019	0.0020	0.0021	0.0021	0.0022	0.0023	0.0023	0.0024	0.0025	0.0026
–2.7	0.0026	0.0027	0.0028	0.0029	0.0030	0.0031	0.0032	0.0033	0.0034	0.0035
–2.6	0.0036	0.0037	0.0038	0.0039	0.0040	0.0041	0.0043	0.0044	0.0045	0.0047
–2.5	0.0048	0.0049	0.0051	0.0052	0.0054	0.0055	0.0057	0.0059	0.0060	0.0062
–2.4	0.0064	0.0066	0.0068	0.0069	0.0071	0.0073	0.0075	0.0078	0.0080	0.0082
–2.3	0.0084	0.0087	0.0089	0.0091	0.0094	0.0096	0.0099	0.0102	0.0104	0.0107
–2.2	0.0110	0.0113	0.0116	0.0119	0.0122	0.0125	0.0129	0.0132	0.0136	0.0139
–2.1	0.0143	0.0146	0.0150	0.0154	0.0158	0.0162	0.0166	0.0170	0.0174	0.0179
–2.0	0.0183	0.0188	0.0192	0.0197	0.0202	0.0207	0.0212	0.0217	0.0222	0.0228
–1.9	0.0233	0.0239	0.0244	0.0250	0.0256	0.0262	0.0268	0.0274	0.0281	0.0287
–1.8	0.0294	0.0301	0.0307	0.0314	0.0322	0.0329	0.0336	0.0344	0.0351	0.0359
–1.7	0.0367	0.0375	0.0384	0.0392	0.0401	0.0409	0.0418	0.0427	0.0436	0.0446
–1.6	0.0455	0.0465	0.0475	0.0485	0.0495	0.0505	0.0516	0.0526	0.0537	0.0548
–1.5	0.0559	0.0571	0.0582	0.0594	0.0606	0.0618	0.0630	0.0643	0.0655	0.0668
–1.4	0.0681	0.0694	0.0708	0.0721	0.0735	0.0749	0.0764	0.0778	0.0793	0.0808
–1.3	0.0823	0.0838	0.0853	0.0869	0.0885	0.0901	0.0918	0.0934	0.0951	0.0968
–1.2	0.0985	0.1003	0.1020	0.1038	0.1056	0.1075	0.1093	0.1112	0.1131	0.1151
–1.1	0.1170	0.1190	0.1210	0.1230	0.1251	0.1271	0.1292	0.1314	0.1335	0.1357
–1.0	0.1379	0.1401	0.1423	0.1446	0.1469	0.1492	0.1515	0.1539	0.1562	0.1587
–0.9	0.1611	0.1635	0.1660	0.1685	0.1711	0.1736	0.1762	0.1788	0.1814	0.1841
–0.8	0.1867	0.1894	0.1922	0.1949	0.1977	0.2005	0.2033	0.2061	0.2090	0.2119
–0.7	0.2148	0.2177	0.2206	0.2236	0.2266	0.2296	0.2327	0.2358	0.2389	0.2420
–0.6	0.2451	0.2483	0.2514	0.2546	0.2578	0.2611	0.2643	0.2676	0.2709	0.2743
–0.5	0.2776	0.2810	0.2843	0.2877	0.2912	0.2946	0.2981	0.3015	0.3050	0.3085
–0.4	0.3121	0.3156	0.3192	0.3228	0.3264	0.3300	0.3336	0.3372	0.3409	0.3446
–0.3	0.3483	0.3520	0.3557	0.3594	0.3632	0.3669	0.3707	0.3745	0.3783	0.3821
–0.2	0.3859	0.3897	0.3936	0.3974	0.4013	0.4052	0.4090	0.4129	0.4168	0.4207
–0.1	0.4247	0.4286	0.4325	0.4364	0.4404	0.4443	0.4483	0.4522	0.4562	0.4602
–0.0	0.4641	0.4681	0.4721	0.4761	0.4801	0.4840	0.4880	0.4920	0.4960	0.5000

Table 18 - Table of Probabilities Associated with Values of +Z in a Normal Distribution

z	0	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0	0.5000	0.5040	0.5080	0.5120	0.5160	0.5199	0.5239	0.5279	0.5319	0.5359
0.1	0.5398	0.5438	0.5478	0.5517	0.5557	0.5596	0.5636	0.5675	0.5714	0.5753
0.2	0.5793	0.5832	0.5871	0.5910	0.5948	0.5987	0.6026	0.6064	0.6103	0.6141
0.3	0.6179	0.6217	0.6255	0.6293	0.6331	0.6368	0.6406	0.6443	0.6480	0.6517
0.4	0.6554	0.6591	0.6628	0.6664	0.6700	0.6736	0.6772	0.6808	0.6844	0.6879
0.5	0.6915	0.6950	0.6985	0.7019	0.7054	0.7088	0.7123	0.7157	0.7190	0.7224
0.6	0.7257	0.7291	0.7324	0.7357	0.7389	0.7422	0.7454	0.7486	0.7517	0.7549
0.7	0.7580	0.7611	0.7642	0.7673	0.7704	0.7734	0.7764	0.7794	0.7823	0.7852
0.8	0.7881	0.7910	0.7939	0.7967	0.7995	0.8023	0.8051	0.8078	0.8106	0.8133
0.9	0.8159	0.8186	0.8212	0.8238	0.8264	0.8289	0.8315	0.8340	0.8365	0.8389
1	0.8413	0.8438	0.8461	0.8485	0.8508	0.8531	0.8554	0.8577	0.8599	0.8621
1.1	0.8643	0.8665	0.8686	0.8708	0.8729	0.8749	0.8770	0.8790	0.8810	0.8830
1.2	0.8849	0.8869	0.8888	0.8907	0.8925	0.8944	0.8962	0.8980	0.8997	0.9015
1.3	0.9032	0.9049	0.9066	0.9082	0.9099	0.9115	0.9131	0.9147	0.9162	0.9177
1.4	0.9192	0.9207	0.9222	0.9236	0.9251	0.9265	0.9279	0.9292	0.9306	0.9319
1.5	0.9332	0.9345	0.9357	0.9370	0.9382	0.9394	0.9406	0.9418	0.9429	0.9441
1.6	0.9452	0.9463	0.9474	0.9484	0.9495	0.9505	0.9515	0.9525	0.9535	0.9545
1.7	0.9554	0.9564	0.9573	0.9582	0.9591	0.9599	0.9608	0.9616	0.9625	0.9633
1.8	0.9641	0.9649	0.9656	0.9664	0.9671	0.9678	0.9686	0.9693	0.9699	0.9706
1.9	0.9713	0.9719	0.9726	0.9732	0.9738	0.9744	0.9750	0.9756	0.9761	0.9767
2	0.9772	0.9778	0.9783	0.9788	0.9793	0.9798	0.9803	0.9808	0.9812	0.9817
2.1	0.9821	0.9826	0.9830	0.9834	0.9838	0.9842	0.9846	0.9850	0.9854	0.9857
2.2	0.9861	0.9864	0.9868	0.9871	0.9875	0.9878	0.9881	0.9884	0.9887	0.9890
2.3	0.9893	0.9896	0.9898	0.9901	0.9904	0.9906	0.9909	0.9911	0.9913	0.9916
2.4	0.9918	0.9920	0.9922	0.9925	0.9927	0.9929	0.9931	0.9932	0.9934	0.9936
2.5	0.9938	0.9940	0.9941	0.9943	0.9945	0.9946	0.9948	0.9949	0.9951	0.9952
2.6	0.9953	0.9955	0.9956	0.9957	0.9959	0.9960	0.9961	0.9962	0.9963	0.9964
2.7	0.9965	0.9966	0.9967	0.9968	0.9969	0.9970	0.9971	0.9972	0.9973	0.9974
2.8	0.9974	0.9975	0.9976	0.9977	0.9977	0.9978	0.9979	0.9979	0.9980	0.9981
2.9	0.9981	0.9982	0.9982	0.9983	0.9984	0.9984	0.9985	0.9985	0.9986	0.9986
3	0.9987	0.9987	0.9987	0.9988	0.9988	0.9989	0.9989	0.9989	0.9990	0.9990
3.1	0.9990	0.9991	0.9991	0.9991	0.9992	0.9992	0.9992	0.9992	0.9993	0.9993
3.2	0.9993	0.9993	0.9994	0.9994	0.9994	0.9994	0.9994	0.9995	0.9995	0.9995
3.3	0.9995	0.9995	0.9995	0.9996	0.9996	0.9996	0.9996	0.9996	0.9996	0.9997
3.4	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9998

APPENDIX G ANTHROPOMETRIC DATABASE TOOL

In the future it is anticipated that the anthropometric database tool will be made available through the Knowledge in Defence (KiD) website. However, at the time of writing this is not the case. If the database is not available through HuFIMS, it can be requested for use in MoD acquisition projects by contacting the DE&S Human Factors Integration Practice Lead, MoD Abbey Wood, Bristol, BS34 8JH, Tel. 030 679 81583 (DESTECH-EGHFI-Team@mod.gov.uk).

Data generated from the survey is held in Version 2 of the Anthropometry Database, which is made available through a purpose-designed user interface. The database utilises Microsoft's .NET Framework, version 3.5 and is fully supported on Windows XP (Service Pack 3), Windows 7 and Windows 8.

When accessed, the database allows the user to select the set of personnel of interest (see Figure 31).

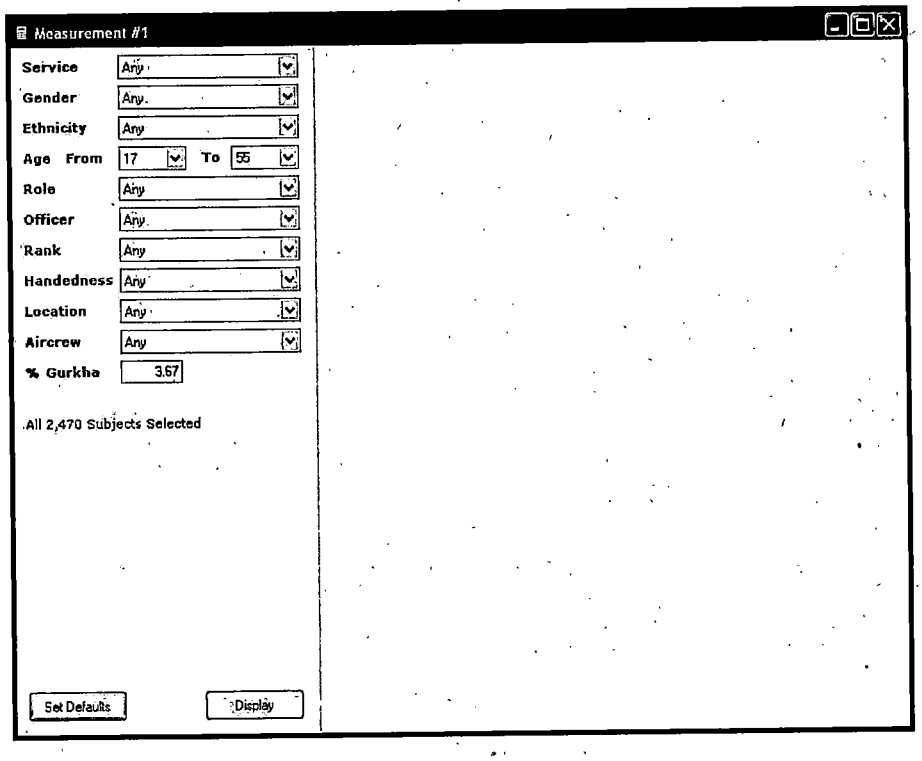

Figure 31 – MoD Anthropometric Database – Data Selection Screen

The initial data selection screen allows the user to select data for all 2470 subjects, or a selected subset that satisfies certain parameters. The various parameters that the user can select are listed in Table 19.

Table 19 – Anthropometric Database Parameters

Parameter	Selectable Values
Service	Any / Army / Royal Air Force / Royal Navy / Royal Marines
Sex	Any / Male / Female
Ethnicity	Any White-Caucasian Back- Caribbean Black-African Black-Other Origin East African Indian Asian of Other Origin Gurkha Fijian Other Ethnic Group
Age	Selectable upper and lower limits between 17 and 55 years
Role	Any, one of 49 roles can be selected
Officer	Any / No / Yes
Rank	Any, one of 66 ranks can be selected
Handedness	Any / Left / Right
Location	Any / one of 21 locations where measurements were taken
Aircrew	Any / No / Yes
% Gurkha	Enables the user to select the percentage Gurkhas included in the survey (default set to 3.67%). N.B. This only affects the Army Male data, a setting of 0% would exclude the Gurkhas from any database calculations.

Using separate identical screens, any number of measurements can be explored. The user can select from the following major body parts using a representation of a standing figure:

- Head;
- Neck;
- Upper Body;
- Loins;
- Upper Leg;
- Lower Leg/Foot;
- Arm; and
- Hand.

The screen also allows the user to select all data per selected subject group, or a selected sub-set, namely:

- Circumferences;
- Heights;
- Lengths;
- Breadths;
- Sitting; and
- Non-linear measurements.

The following data are available (all dimensions are presented in mm unless otherwise shown):

Table 20 – Anthropometric Database Content

Body Part	Measurement
Whole Body	Stature
	Weight (kg)
Head	Head circumference
	Pupil to vertex
	Interpupillary breadth
	Sitting height
	Eye height, sitting
	Chin height
	Eye height, standing
Neck	Neck height, lateral, left
	Neck height, back (cervicale height)
	Neck circumference
	Neck height, lateral, right
	Neck base height, front
Upper Body	Acromial height, left
	Inter-elbow span
	Chest (bustpoint) height
	Neck height, back (cervicale height)
	Chest circumference at axilla
	Chest circumference at bustpoint
	Chest circumference below bust
	Vertical trunk circumference, left
	Stomach depth, sitting
	Midshoulder height, sitting
	Biacromial breadth
	Bideltoid breadth
	Bustpoint breadth
	Chest depth
	Spine to scye, half back
	Spine to elbow
	Spine to wrist
	Acromial height, right
	Chest (axilla level) height
	Underbust circumference height
	Back breadth, across base of scyes
	Abdomen buttock depth
	Vertical trunk circumference, right
	Back waist length
	Side back, waist to ground, left

Body Part	Measurement
	Side back, waist to ground, right
	Cervicale to breast point, left
	Cervicale to breast point, right
	Cervicale to waist (natural)
	Shoulder slope, left
	Shoulder slope, right
	Bust prominence, left
	Bust prominence, right
	Stomach depth (to individuals back), sitting
Waist	Waist height, natural indent
	Buttock (hip) height
	Crotch height
	Waist circumference (natural indent)
	Buttock circumference
	Vertical trunk circumference, left
	Stomach depth, sitting
	Buttock to knee length
	Buttock popliteal length
	Sitting height
	Eye height, sitting
	Mid shoulder height, sitting
	Elbow rest height, sitting
	Hip breadth, sitting
	Hip breadth standing
	Abdomen buttock depth
	Vertical trunk circumference, right
	Back waist length
	Side back, waist to ground, left
	Side back, waist to ground, right
	Cervicale to waist (natural)
	Side waist to hip, left
	Side waist to hip, right
	Crotch length
	Stomach depth (to individuals back), sitting
Leg	Knee height, left
	Calf height, left
	Thigh circumference, left
	Calf circumference, left
	Knee, fully bent, circumference
	Thigh clearance height
	Knee height, sitting
	Buttock to knee length

Body Part	Measurement
	Buttock popliteal length
	Popliteal height
	Thigh height
	Mid thigh height, left
	Mid thigh height, right
	Knee height, right
	Calf height, right
	Thigh circumference, right
	Mid thigh circumference, left
	Mid thigh circumference, right
	Knee circumference, left
	Knee circumference, right
	Calf circumference, right
	Outside leg length, left
	Outside leg length, right
Feet	Heel to instep circumference, left
	Ankle circumference height, left
	Ankle circumference, left
	Ankle circumference height, right
	Ankle bone height, inside, left
	Ankle bone height, inside, right
	Ankle bone height, outside, left
	Ankle bone height, outside, right
	Ankle circumference, right
	Ankle bone circumference, left
	Ankle bone circumference, right
	Heel to instep circumference, right
Arm	Acromial height, left
	Axilla height (armscye), left
	Inter-elbow span
	Elbow to thumb tip (functional reach)
	Elbow, fully bent, circumference
	Horizontal functional reach, sitting
	Elbow rest height, sitting
	Biacromial breadth
	Bideltoid breadth
	Spine to scye, half back
	Spine to elbow
	Acromial height, right
	Axilla height (armscye), right
	Upper arm circumference (biceps) , left
	Upper arm circumference (biceps)., right

Body Part	Measurement
	Elbow circumference, left
	Elbow circumference, right
	Forearm circumference, left
	Forearm circumference, right
	Shoulder slope, left
	Shoulder slope, right
	Elbow rest height, standing
	Shoulder height, standing
	Vertical functional reach, standing
	Acromial to wrist, right
	Vertical functional reach, sitting
	Acromial to elbow length
Hand	Elbow to thumb tip (functional reach)
	Hand length
	Wrist circumference, left
	Hand circumference
	Hand breadth
	Horizontal functional reach, sitting
	Spine to wrist
	Wrist circumference, right
	Vertical functional reach, standing
	Acromial to wrist, left
	Vertical functional reach, sitting

In Version 2 of the Tri-Service Anthropometric Database data can also be extracted for clothed personnel. Data are provided for the following clothing ensembles:

- Nude;
- Dismount Summer;
- Dismount Winter;
- Dismount Winter (ECW);
- Driver (20 Degrees recline) Summer;
- Driver (20 Degrees recline) Winter;
- Driver (20 Degrees recline) Winter (ECW);
- Driver Summer;
- Driver Winter; and
- Driver Winter (ECW).

Having selected the required data, the user is presented with the display illustrated in Figure 32.

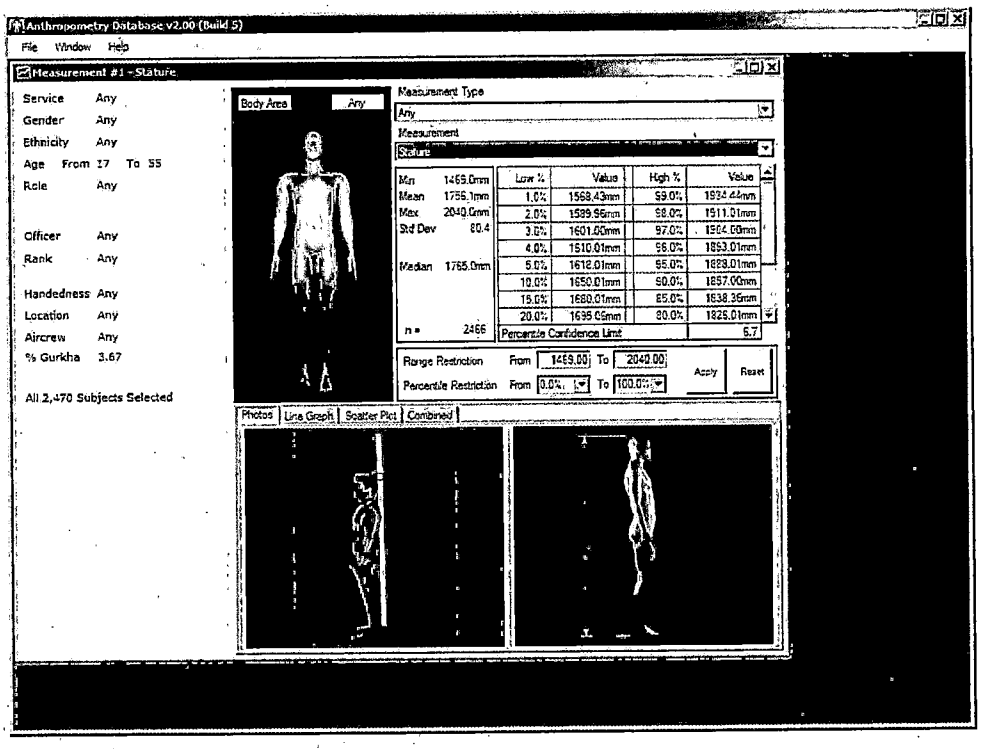

Figure 32 – Anthropometric Database Data Display

In place of the default image of the measurement technique, the user may select a 'Line Graph 'display of the data showing how it varies throughout the population range. The database also allows measurements to be viewed next to each other as shown in Figure 33. The graphs have been updated and can be re-sized by the user to fill the available screen size.

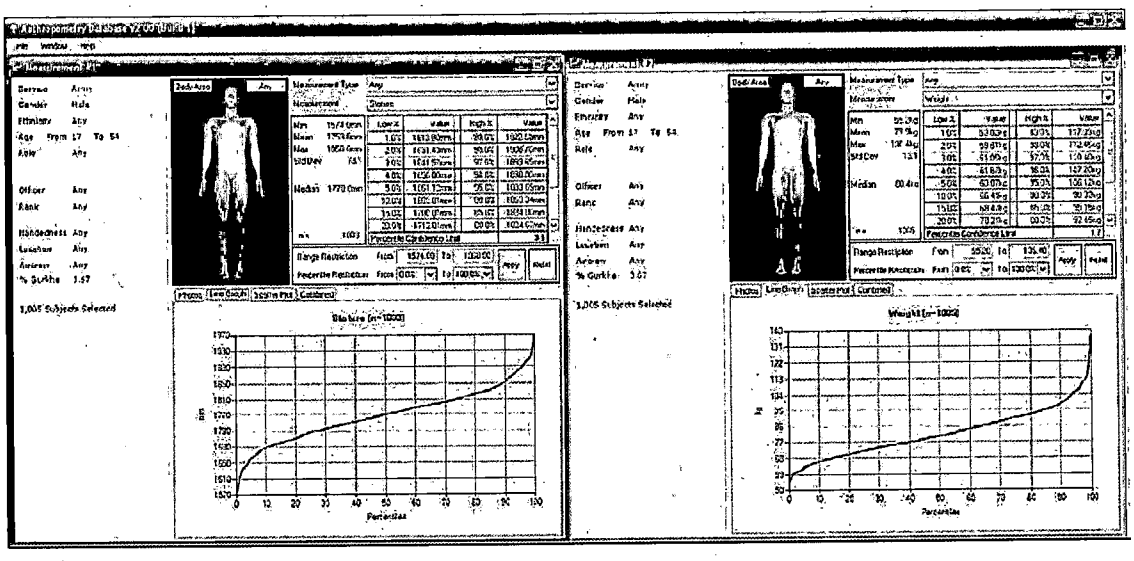

Figure 33 – Line Graph Display of Selected Data

For the selected measurement, the screen displays:

- Min value;
- Mean value;
- Maximum value;
- Standard Deviation;
- Median; and
- Values for percentiles: 1, 2, 3, 4, 5, 10, 20, 25, 30, 40, 50, 60, 70, 75, 80, 85, 90, 95, 96, 97, 98 & 99.

The user can select a smaller percentile range and filter results against this reduced range.

Selecting the 'Combined' tab on the measurements screen will allow the user to select any of the measurements previously opened from the same data sets for comparison. If, for example, the user selects a 0% to 95% restriction for stature and for weight, the database will list the percentage of personnel who fit both restrictions. In the example below in Figure 34 this equates to 91.6% of the population fitting both restrictions. The old database (Version 1) could represent a maximum of up to three measurements for comparison; the new database now fits as many measurements as desired.

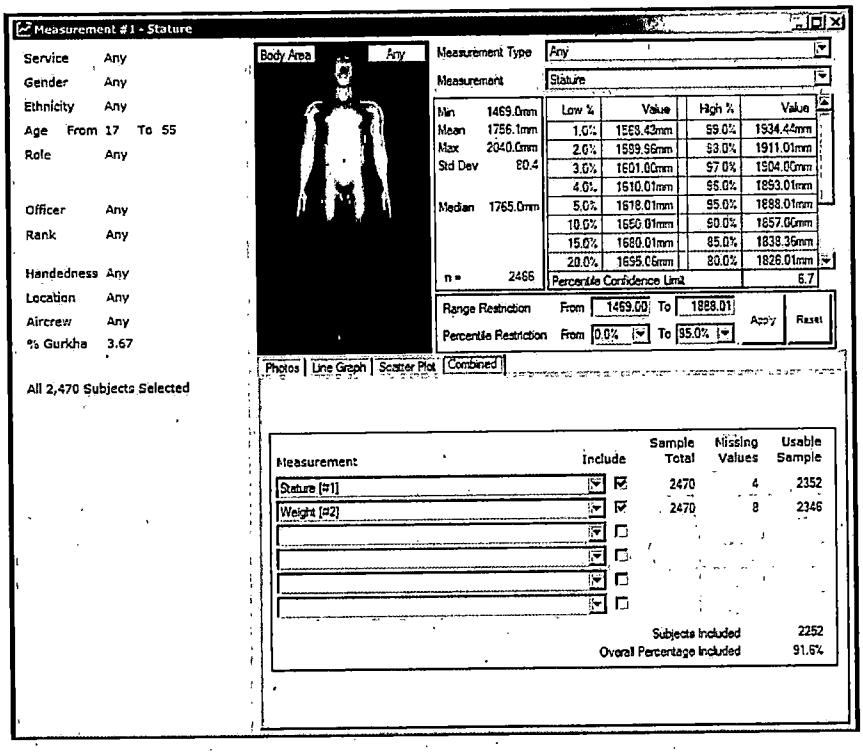

Figure 34 – Displaying Subjects That Fit the 0-95% Restrictions for Stature and Weight

Design Best Practice Note 33:
At the time of writing this Technical Guide there is ongoing work to generate anthropometric data for the Royal Armoured Corps. This will affect the data included in some of the anthropometric data tables included in Appendix H. The reader should contact Dstl or the DE&S HFI cell for the most up-to-date version of the Tri-Service Anthropometric database.

APPENDIX H ANTHROPOMETRIC DATABASE SUMMARY TABLES

For the convenience of users of this anthropometric guide, certain data have been extracted from the MoD Anthropometric database (Pringle, et al., 2011) and (Pringle, et al., 2013). These data are presented in Table 21 to Table 32 inclusive (all dimensions listed are provided in mm and have been rounded to the nearest mm). The data have been separated into eleven different user populations that may have to be accounted for in a system design as follows:

(a) All Services & Groups – Male;
(b) All Services & Groups – Female;
(c) Army – Male;
(d) Army – Female;
(e) Gurkha;
(f) Air Force – Male;
(g) Air Force – Female;
(h) Aircrew;
(i) Royal Navy – Male;
(j) Royal Navy – Female; and
(k) Royal Marines.

Some of the extracted variables are deduced:

(a) Standing Shoulder Height: Deduced by subtracting (Sitting Height - Sitting Shoulder Height) from Stature;
(b) Eye Height, Standing: Deduced by subtracting (Sitting Height – Sitting Eye Height) from Stature;
(c) Standing Elbow Height: Deduced by subtracting (Sitting Height - Elbow Rest Height) from Stature;
(d) Standing Eye Height: Deduced by subtracting Pupil to Vertex measurement from Stature;
(e) Pupil to Vertex: Deduced by subtracting Sitting eye height from Sitting Height

H.1 ANTHROPOMETRIC DATA - ALL SERVICES & GROUPS – MALE

Table 21 provides anthropometric data for males including all services and groups. Therefore, these data provide a summary of all male data for the Army, Royal Air Force, Royal Navy, as well as specific population groups i.e. the Gurkhas, the Royal Marines, and Aircrew.

This dataset **should** be applied in instances where a joint capability will be produced for use by all of the armed forces irrespective of service or combat role. Examples of instances where these data may be applied include the design of general clothing and equipment ensembles, weapon systems and the design of facilities such as Joint Forces Headquarters.

These data **should not** be used in the acquisition of equipment or capabilities which may be used by a specific service or sub-group of the population.

Table 21 – Anthropometric Data - All Services & Groups – Male (Sample Size: 2159)

Anthropometric Data - All Services & Groups – Male (All Dimensions are provided in mm)					
Dimension	3rd %ile	5th %ile	50th %ile	95th %ile	97th %ile
1) Stature	1644	1664	1777	1891	1906
2) Eye height, standing	1555	1566	1676	1787	1801
3) Acromial height	1326	1343	1449	1555	1569
4) Elbow rest height, standing	1019	1032	1115	1201	1213
5) Foot Length	246	249	271	295	298
6) Bideltoid breadth	461	466	514	580	590
7) Biacromial breadth	346	351	389	430	439
8) Crotch height	738	748	830	919	930
9) Shoulder height, standing	1391	1409	1503	1605	1622
10) Hip breadth, standing	313	317	348	394	402
11) Waist (natural) circumference	730	744	864	1063	1100
12) Inter-elbow span	876	889	972	1058	1069
13) Buttock - Popliteal length	427	435	483	528	535
14) Buttock-knee length	551	560	610	661	669
15) Stomach depth (to wall)	232	237	286	359	374

Anthropometric Data - All Services & Groups – Male (All Dimensions are provided in mm)					
Dimension	**3rd %ile**	**5th %ile**	**50th %ile**	**95th %ile**	**97th %ile**
16) Elbow functional reach	370	376	414	450	456
17) Elbow rest height, sitting	184	193	249	305	314
18) Vertical functional reach, sitting	1204	1216	1326	1429	1448
19) Functional reach (horizontal thumb tip reach), sitting	742	754	821	889	898
20) Sitting height	827	837	912	971	979
21) Eye height, sitting	737	745	811	873	885
22) Thigh clearance height	117	121	149	184	187
23) Stool height	364	367	411	455	462
24) Popliteal height	373	379	422	465	472
25) Knee height, sitting	485	491	534	594	603
26) Head length	188	190	202	213	215
27) Pupil to vertex	55	59	102	128	132
28) Head breadth	148	149	158	167	168
29) Hip breadth, sitting	334	338	377	415	420
30) Head circumference	550	552	578	605	610
31) Foot Breadth	87	89	100	111	113
32) Hand breadth	80	82	90	97	98
33) Hand length	177	180	200	221	224
34) Wrist circumference	153	155	172	190	192
35) Sitting shoulder height	577	584	638	692	703
36) Chest Depth	212	217	254	302	309

Anthropometric Data - All Services & Groups – Male (All Dimensions are provided in mm)					
Dimension	3rd %ile	5th %ile	50th %ile	95th %ile	97th %ile
37) Interpupillary Distance	58	59	64	70	71
Weight (kg)	61	64	81	106	110

H.2 ANTHROPOMETRIC DATA - ALL SERVICES & GROUPS – FEMALE

Table 22 provides anthropometric data for females including all services and groups. Therefore, these data provide a summary of all female data for the Army, Royal Air Force, Royal Navy, as well as Aircrew as a specific population groups (note, at the time of the anthropometric survey no female Gurkhas or Royal Marines were included in the survey).

This dataset **should** be applied in instances where a joint capability will be produced for use by all of the armed forces irrespective of service or combat role. Examples of instances where these data may be applied include the design of general clothing and equipment ensembles, weapon systems and the design of facilities such as Joint Forces Headquarters.

These data **should not** be used in the acquisition of equipment or capabilities which may be used by a specific service or sub-group of the population.

Table 22 – Anthropometric Data - All Services & Groups – Female (Sample Size: 311)

Anthropometric Data - All Services and Groups - Female (All Dimensions are provided in mm)					
Dimension	**3rd %ile**	**5th %ile**	**50th %ile**	**95th %ile**	**97th %ile**
1) Stature	1531	1551	1650	1771	1788
2) Eye height, standing	1448	1466	1562	1688	1709
3) Acromial height	1258	1267	1354	1466	1486
4) Elbow rest height, standing	957	970	1061	1144	1156
5) Foot Length	228	229	250	271	275
6) Bideltoid breadth	421	430	478	552	562
7) Biacromial breadth	299	302	338	378	385
8) Crotch height	724	734	795	876	895
9) Shoulder height, standing	1295	1305	1399	1495	1521
10) Hip breadth, standing	305	309	350	405	411
11) Waist (natural) circumference	654	668	777	939	980
12) Inter-elbow span	822	832	898	978	990
13) Buttock - Popliteal length	422	429	469	516	527
14) Buttock-knee length	529	542	593	651	663
15) Stomach depth (to wall)	215	219	267	336	348

Anthropometric Data - All Services and Groups - Female (All Dimensions are provided in mm)					
Dimension	3rd %ile	5th %ile	50th %ile	95th %ile	97th %ile
16) Elbow functional reach	342	346	376	412	417
17) Elbow rest height, sitting	202	208	255	310	320
18) Vertical functional reach, sitting	1122	1130	1225	1334	1348
19) Functional reach (horizontal thumb tip reach), sitting	674	685	750	814	824
20) Sitting height	775	784	846	926	934
21) Eye height, sitting	691	706	762	845	856
22) Thigh clearance height	110	113	137	174	176
23) Stool height	339	348	381	424	429
24) Popliteal height	346	350	382	419	424
25) Knee height, sitting	451	456	493	535	547
26) Head length	182	183	193	204	205
27) Pupil to vertex	47	52	85	118	121
28) Head breadth	142	142	151	163	164
29) Hip breadth, sitting	340	347	384	425	428
30) Head circumference	528	530	554	583	587
31) Foot Breadth	78	79	89	102	103
32) Hand breadth	71	72	79	86	86
33) Hand length	160	164	186	204	207
34) Wrist circumference	137	141	156	174	177
35) Sitting shoulder height	535	549	595	656	663
36) Chest Depth	207	210	245	302	310

Anthropometric Data - All Services and Groups - Female (All Dimensions are provided in mm)					
Dimension	3rd %ile	5th %ile	50th %ile	95th %ile	97th %ile
37) Interpupillary Distance	55	56	61	67	67
Weight (kg)	50	52	67	91	95

H.3 ANTHROPOMETRIC DATA - ARMY – MALE (INCLUDING GURKHAS)

Table 23 provides anthropometric data for all males in the British Army (including the Gurkha regiments 3.67%). Data for all males in the British Army (excluding the Gurkha regiments) is provided below in H.4.
Data for the Gurkha population are provided as a specific group below in section H.6.

This dataset **should** be applied in instances where an equipment or capability is being acquired for use by the Army. Examples of instances where these data may be applied include the design of equipment such as vehicles, shelters and equipment that may be used by the mounted or dismounted soldier.

These data **should not** be used in the acquisition of equipment or capabilities which will be used purely by the Royal Navy or Royal Air Force.

Table 23 – Anthropometric Data - Army – Male (Sample Size: 1005)

Anthropometric Data - Army - Male (All Dimensions are provided in mm)					
Dimension	3rd %ile	5th %ile	50th %ile	95th %ile	97th %ile
1) Stature	1642	1661	1770	1884	1900
2) Eye height, standing	1558	1566	1674	1778	1796
3) Acromial height	1321	1339	1442	1541	1565
4) Elbow rest height, standing	1019	1032	1115	1198	1209
5) Foot Length	245	248	271	293	295
6) Bideltoid breadth	458	463	512	574	583
7) Biacromial breadth	342	347	386	428	434
8) Crotch height	739	746	829	914	921
9) Shoulder height, standing	1399	1409	1500	1597	1613
10) Hip breadth, standing	313	315	346	394	401
11) Waist (natural) circumference	727	739	857	1055	1076
12) Inter-elbow span	875	886	965	1048	1062
13) Buttock - Popliteal length	422	430	478	524	532
14) Buttock-knee length	548	555	608	658	665
15) Stomach depth (to wall)	229	234	283	357	369

Anthropometric Data - Army - Male (All Dimensions are provided in mm)					
Dimension	3rd %ile	5th %ile	50th %ile	95th %ile	97th %ile
16) Elbow functional reach	365	374	411	448	456
17) Elbow rest height, sitting	177	190	249	307	315
18) Vertical functional reach, sitting	1201	1213	1321	1414	1432
19) Functional reach (horizontal thumb tip reach), sitting	741	754	820	886	895
20) Sitting height	821	831	906	965	971
21) Eye height, sitting	734	742	807	869	876
22) Thigh clearance height	116	120	150	184	189
23) Stool height	359	365	406	450	457
24) Popliteal height	370	377	419	459	470
25) Knee height, sitting	482	490	531	587	592
26) Head length	187	189	201	212	213
27) Pupil to vertex	51	56	99	126	131
28) Head breadth	147	148	157	166	168
29) Hip breadth, sitting	332	337	375	414	419
30) Head circumference	547	552	575	603	608
31) Foot Breadth	87	90	101	112	114
32) Hand breadth	80	82	89	97	98
33) Hand length	177	180	201	223	225
34) Wrist circumference	154	156	173	189	192
35) Sitting shoulder height	575	581	635	690	702
36) Chest Depth	211	214	253	300	306

Anthropometric Data - Army - Male (All Dimensions are provided in mm)					
Dimension	3rd %ile	5th %ile	50th %ile	95th %ile	97th %ile
37) Interpupillary Distance	57	58	64	70	71
Weight (kg)	61	63	80	106	110

H.4 ANTHROPOMETRIC DATA - ARMY – MALE (EXCLUDING GURKHAS)

Table 24 provides anthropometric data for all males in the British Army (excluding the Gurkha regiments which currently account for 3.67% of the British Army). Data for the Gurkha population are provided as a specific group below in section H.6.

This dataset **should** be applied in instances where an equipment or capability is being acquired for use by the Army which will not be used by the Gurkha Regiments. Examples of instances where these data may be applied include the design of equipment such as vehicles, shelters and equipment that may be used by the mounted or dismounted soldier.

These data **should not** be used in the acquisition of equipment or capabilities which will be used purely by the Royal Navy or Royal Air Force.

Table 24 – Anthropometric Data - Army – Male (Excluding Gurkhas) (Sample Size: 1005)

Anthropometric Data - Army - Male (Excluding Gurkhas) (All Dimensions are provided in mm)					
Dimension	**3rd %ile**	**5th %ile**	**50th %ile**	**95th %ile**	**97th %ile**
1) Stature	1651	1675	1773	1884	1890
2) Eye height, standing	1561	1575	1677	1779	1796
3) Acromial height	1336	1354	1446	1540	1558
4) Elbow rest height, standing	1029	1039	1118	1198	1209
5) Foot Length	247	250	271	293	295
6) Bideltoid breadth	459	463	514	575	583
7) Biacromial breadth	342	348	387	428	434
8) Crotch height	741	751	830	914	921
9) Shoulder height, standing	1406	1417	1503	1598	1613
10) Hip breadth, standing	313	315	347	394	401
11) Waist (natural) circumference	728	739	860	1057	1076
12) Inter-elbow span	882	896	967	1048	1062
13) Buttock - Popliteal length	426	431	479	524	532
14) Buttock-knee length	553	559	609	658	665
15) Stomach depth (to wall)	229	234	284	357	369
16) Elbow functional reach	368	376	412	448	456

Anthropometric Data - Army - Male (Excluding Gurkhas) (All Dimensions are provided in mm)					
Dimension	3rd %ile	5th %ile	50th %ile	95th %ile	97th %ile
17) Elbow rest height, sitting	176	191	250	307	315
18) Vertical functional reach, sitting	1208	1216	1323	1414	1432
19) Functional reach (horizontal thumb tip reach), sitting	751	756	820	886	895
20) Sitting height	824	833	908	965	971
21) Eye height, sitting	738	742	808	869	876
22) Thigh clearance height	116	121	150	184	189
23) Stool height	362	366	408	450	457
24) Popliteal height	375	379	420	459	470
25) Knee height, sitting	490	494	532	587	592
26) Head length	188	190	201	212	213
27) Pupil to vertex	51	56	100	126	131
28) Head breadth	147	148	157	166	168
29) Hip breadth, sitting	332	337	375	414	419
30) Head circumference	548	552	575	603	608
31) Foot Breadth	87	90	101	112	114
32) Hand breadth	80	82	90	97	98
33) Hand length	178	180	202	223	225
34) Wrist circumference	155	157	173	189	192
35) Sitting shoulder height	576	583	636	690	702
36) Chest Depth	211	214	254	300	306
37) Interpupillary Distance	57	58	64	70	71

Anthropometric Data - Army - Male (Excluding Gurkhas) (All Dimensions are provided in mm)					
Dimension	3rd %ile	5th %ile	50th %ile	95th %ile	97th %ile
Weight (kg)	61	63	81	106	110

H.5 ANTHROPOMETRIC DATA - ARMY – FEMALE

Table 25 provides anthropometric data for all females in the British Army. Therefore, these data provide a summary of all female data for all Corps and Regiments. At the time of writing females do not currently serve in the Royal Armoured Corps (RAC), however, RAC vehicles may be maintained by females and it would be unwise to assume that in the future all RAC vehicles will not be operated by females.

This dataset **should** be applied in instances where an equipment or capability is being acquired for use by the Army. Examples of instances where these data may be applied include the design of equipment such as vehicles, shelters and equipment that may be used by the mounted or dismounted soldier.

These data **should not** be used in the acquisition of equipment or capabilities which will be used purely by the Royal Navy or Royal Air Force.

Table 25 – Anthropometric Data - Army – Female (Sample Size: 84)

Anthropometric Data - Army - Female (All Dimensions are provided in mm)					
Dimension	3rd %ile	5th %ile	50th %ile	95th %ile	97th %ile
1) Stature	1527	1559	1640	1752	1762
2) Eye height, standing	1428	1470	1561	1654	1664
3) Acromial height	1226	1270	1354	1438	1456
4) Elbow rest height, standing	877	952	1058	1143	1146
5) Foot Length	228	228	250	269	270
6) Bideltoid breadth	432	433	478	546	555
7) Biacromial breadth	305	312	341	376	381
8) Crotch height	710	736	794	865	877
9) Shoulder height, standing	1248	1296	1403	1481	1511
10) Hip breadth, standing	305	309	341	398	411
11) Waist (natural) circumference	664	673	765	944	979
12) Inter-elbow span	832	834	889	975	981
13) Buttock - Popliteal length	419	426	466	501	509
14) Buttock-knee length	537	544	582	630	633

Anthropometric Data - Army - Female (All Dimensions are provided in mm)					
Dimension	3rd %ile	5th %ile	50th %ile	95th %ile	97th %ile
15) Stomach depth (to wall)	207	213	259	336	339
16) Elbow functional reach	341	344	376	401	407
17) Elbow rest height, sitting	184	210	257	320	332
18) Vertical functional reach, sitting	1094	1119	1224	1315	1328
19) Functional reach (horizontal thumb tip reach), sitting	672	680	750	800	806
20) Sitting height	761	773	839	935	940
21) Eye height, sitting	672	685	762	836	858
22) Thigh clearance height	112	115	133	166	169
23) Stool height	348	354	376	420	424
24) Popliteal height	341	344	383	415	417
25) Knee height, sitting	455	462	491	528	530
26) Head length	182	183	192	204	206
27) Pupil to vertex	48	49	79	121	123
28) Head breadth	139	140	149	158	161
29) Hip breadth, sitting	342	344	378	423	424
30) Head circumference	519	527	549	578	578
31) Foot Breadth	78	79	91	102	102
32) Hand breadth	73	73	80	86	86
33) Hand length	159	162	187	202	203
34) Wrist circumference	142	144	156	174	174
35) Sitting shoulder height	521	537	593	661	664

Anthropometric Data - Army - Female (All Dimensions are provided in mm)					
Dimension	3rd %ile	5th %ile	50th %ile	95th %ile	97th %ile
36) Chest Depth	208	209	242	303	311
37) Interpupillary Distance	54	58	61	67	68
Weight (kg)	53	54	67	87	91

H.6 ANTHROPOMETRIC DATA – GURKHA

Table 26 provides anthropometric data for Gurkha soldiers in the British Army. Therefore, these data are specific only to British Army Gurkha regiments. The Gurkha population was singled out as a significant ethnic group with known anthropometric differences from the general UK Army (Gooderson, 1977). There are significant anthropological differences between Gurkhas and the rest of the Army and therefore the population is treated as a separate population in its own right. If the target population is more extensive than solely Gurkhas; other appropriate data sets should be referred to in addition to the data given in this section.

This data set is rarely used as generally the Gurkha population sits within the extremes of the male and female Army populations, therefore designing to the 5th – 95th percentile male and female data should encompass the Gurkha population as well. The Gurkha population has been separated as a specific group from the remainder of the Army data set as smaller size of the Gurkha population tends to skew the rest of the army male data when incorporated.

This dataset should be applied in instances where an equipment or capability is being acquired for use by the Gurkhas. Examples of instances where these data may be applied include the design of clothing and equipment that may be used by the mounted or dismounted soldier.

These data should not solely be used in the acquisition of equipment that will not be used by the Gurkhas.

Table 26 – Anthropometric Data – Gurkha (Sample Size: 188)

Anthropometric Data - Gurkha (All Dimensions are provided in mm)					
Dimension	**3rd %ile**	**5th %ile**	**50th %ile**	**95th %ile**	**97th %ile**
1) Stature	1595	1601	1664	1745	1763
2) Eye height, standing	1505	1513	1575	1628	1639
3) Acromial height	1282	1287	1339	1420	1429
4) Elbow rest height, standing	950	981	1038	1105	1114
5) Foot Length	235	236	250	265	269
6) Bideltoid breadth	443	450	487	534	536
7) Biacromial breadth	338	339	365	392	396
8) Crotch height	710	713	765	853	865
9) Shoulder height, standing	1346	1353	1413	1472	1478
10) Hip breadth, standing	300	306	333	369	373
11) Waist (natural) circumference	722	727	812	933	940
12) Inter-elbow span	829	838	892	955	968

Anthropometric Data - Gurkha (All Dimensions are provided in mm)					
Dimension	3rd %ile	5th %ile	50th %ile	95th %ile	97th %ile
13) Buttock - Popliteal length	397	401	445	488	494
14) Buttock-knee length	517	524	561	605	621
15) Stomach depth (to wall)	230	233	265	338	346
16) Elbow functional reach	341	349	383	416	420
17) Elbow rest height, sitting	183	188	233	286	290
18) Vertical functional reach, sitting	1155	1167	1233	1314	1320
19) Functional reach (horizontal thumb tip reach), sitting	710	715	769	814	829
20) Sitting height	804	809	853	914	920
21) Eye height, sitting	720	722	770	819	825
22) Thigh clearance height	111	114	138	159	162
23) Stool height	329	348	368	386	388
24) Popliteal height	351	357	379	402	403
25) Knee height, sitting	452	456	488	508	511
26) Head length	178	180	190	203	206
27) Pupil to vertex	51	59	85	112	118
28) Head breadth	153	154	161	170	170
29) Hip breadth, sitting	322	324	354	382	386
30) Head circumference	543	544	565	588	592
31) Foot Breadth	82	85	94	99	99
32) Hand breadth	79	80	84	91	92
33) Hand length	168	169	189	206	208

Anthropometric Data - Gurkha (All Dimensions are provided in mm)					
Dimension	3rd %ile	5th %ile	50th %ile	95th %ile	97th %ile
34) Wrist circumference	149	151	162	174	175
35) Sitting shoulder height	554	565	605	650	656
36) Chest Depth	211	217	241	266	273
37) Interpupillary Distance	60	61	65	70	71
Weight (kg)	58	59	69	81	83

H.7 ANTHROPOMETRIC DATA - AIR FORCE – MALE

Table 27 provides anthropometric data for all Royal Air Force males excluding aircrew. RAF aircrew are selected on a strict anthropometric basis i.e. candidates for RAF aircrew must fit between maximum and minimum anthropometric dimensions and are therefore treated as a separate population in their own right (further details of aircrew anthropometrics are provided below in section H.9).

This dataset should be applied in instances where a capability will be produced for use by the RAF only. Examples of instances where these data may be applied include the design of RAF clothing and equipment ensembles, ground crew equipment, maintenance aspects of aircraft and the design of facilities such as RAF establishments. If the target population contains people from other services or is solely from a specific sub-set of the RAF (e.g. aircrew) other relevant datasets should be referred to also. This summary is for ALL RAF male population and includes aircrew.

This data should not solely be used in the acquisition of equipment or capabilities which may be used by another service or sub-group of the population such as Aircrew.

Table 27 – Anthropometric Data - Air Force – Male (Sample Size: 514)

Anthropometric Data - Air Force - Male (All Dimensions are provided in mm)					
Dimension	3rd %ile	5th %ile	50th %ile	95th %ile	97th %ile
1) Stature	1669	1686	1786	1898	1909
2) Eye height, standing	1559	1578	1686	1790	1806
3) Acromial height	1350	1364	1458	1561	1574
4) Elbow rest height, standing	1013	1032	1117	1195	1226
5) Foot Length	248	251	273	297	302
6) Bideltoid breadth	467	474	519	598	606
7) Biacromial breadth	350	356	393	435	445
8) Crotch height	739	754	831	921	931
9) Shoulder height, standing	1405	1413	1508	1608	1624
10) Hip breadth, standing	318	322	352	398	406
11) Waist (natural) circumference	739	754	882	1093	1118
12) Inter-elbow span	897	904	982	1065	1079
13) Buttock - Popliteal length	437	442	485	531	535
14) Buttock-knee length	560	568	610	663	672

Anthropometric Data - Air Force - Male (All Dimensions are provided in mm)					
Dimension	3rd %ile	5th %ile	50th %ile	95th %ile	97th %ile
15) Stomach depth (to wall)	235	240	296	373	386
16) Elbow functional reach	380	384	408	452	458
17) Elbow rest height, sitting	191	196	249	304	312
18) Vertical functional reach, sitting	1215	1239	1337	1435	1449
19) Functional reach (horizontal thumb tip reach), sitting	756	763	825	890	901
20) Sitting height	839	858	920	973	980
21) Eye height, sitting	743	752	818	876	891
22) Thigh clearance height	117	121	149	183	186
23) Stool height	376	385	421	463	468
24) Popliteal height	384	387	428	470	477
25) Knee height, sitting	490	497	539	602	611
26) Head length	191	192	203	214	216
27) Pupil to vertex	55	61	104	127	130
28) Head breadth	148	150	158	166	168
29) Hip breadth, sitting	342	347	381	418	423
30) Head circumference	550	553	580	605	612
31) Foot Breadth	87	87	99	113	116
32) Hand breadth	80	81	90	98	98
33) Hand length	179	180	200	221	222
34) Wrist circumference	152	155	172	191	194
35) Sitting shoulder height	577	585	641	691	704

Anthropometric Data - Air Force - Male (All Dimensions are provided in mm)					
Dimension	3rd %ile	5th %ile	50th %ile	95th %ile	97th %ile
36) Chest Depth	216	222	259	308	313
37) Interpupillary Distance	58	59	64	69	70
Weight (kg)	64	66	82	108	112

H.8 ANTHROPOMETRIC DATA - AIR FORCE – FEMALE

Table 28 provides anthropometric data for all Royal Air Force females excluding Aircrew. RAF aircrew are selected on a strict anthropometric basis i.e. candidates for RAF aircrew must fit between maximum and minimum anthropometric dimensions and are therefore treated as a separate population in their own right (further details of aircrew anthropometrics are provided below in section (section H.9).

This dataset should be applied in instances where a capability will be produced for use by the RAF only. Examples of instances where these data may be applied include the design of RAF clothing and equipment ensembles, ground crew equipment, maintenance aspects of aircraft and the design of facilities such as RAF establishments.

These data should not solely be used in the acquisition of equipment or capabilities which may be used by another service or sub-group of the population such as Aircrew.

Table 28 – Anthropometric Data - Air Force – Female (Sample Size: 136)

Anthropometric Data - Air Force - Female (All Dimensions are provided in mm)					
Dimension	**3rd %ile**	**5th %ile**	**50th %ile**	**95th %ile**	**97th %ile**
1) Stature	1536	1555	1650	1773	1814
2) Eye height, standing	1455	1470	1557	1697	1721
3) Acromial height	1258	1265	1353	1482	1496
4) Elbow rest height, standing	990	990	1056	1146	1157
5) Foot Length	232	234	252	275	276
6) Bideltoid breadth	420	438	480	551	562
7) Biacromial breadth	300	303	337	373	377
8) Crotch height	725	735	793	881	898
9) Shoulder height, standing	1297	1304	1395	1500	1520
10) Hip breadth, standing	296	305	349	399	404
11) Waist (natural) circumference	627	656	726	905	909
12) Inter-elbow span	824	831	900	984	1007
13) Buttock - Popliteal length	426	429	465	527	529
14) Buttock-knee length	526	537	588	662	670

Anthropometric Data - Air Force - Female (All Dimensions are provided in mm)					
Dimension	3rd %ile	5th %ile	50th %ile	95th %ile	97th %ile
15) Stomach depth (to wall)	218	221	261	331	348
16) Elbow functional reach	342	349	374	415	416
17) Elbow rest height, sitting	208	210	255	299	308
18) Vertical functional reach, sitting	1127	1130	1232	1329	1347
19) Functional reach (horizontal thumb tip reach), sitting	670	683	743	816	824
20) Sitting height	784	796	855	932	937
21) Eye height, sitting	707	715	764	845	863
22) Thigh clearance height	106	108	138	176	185
23) Stool height	337	346	384	425	429
24) Popliteal height	346	353	382	419	427
25) Knee height, sitting	449	455	492	547	554
26) Head length	182	183	193	204	204
27) Pupil to vertex	46	54	86	116	119
28) Head breadth	142	143	151	161	162
29) Hip breadth, sitting	331	335	382	422	426
30) Head circumference	524	530	555	580	583
31) Foot Breadth	78	79	89	103	104
32) Hand breadth	71	72	78	86	86
33) Hand length	166	170	188	208	210
34) Wrist circumference	133	140	155	176	178
35) Sitting shoulder height	551	551	595	647	661

Anthropometric Data - Air Force - Female (All Dimensions are provided in mm)					
Dimension	3rd %ile	5th %ile	50th %ile	95th %ile	97th %ile
36) Chest Depth	206	211	243	289	298
37) Interpupillary Distance	55	56	61	66	66
Weight (kg)	49	51	66	90	94

H.9 ANTHROPOMETRIC DATA - AIRCREW

Table 29 provides anthropometric data for aircrew from all three services (note much of the data are sourced from the RAF with limited samples from the Army Air Corps and Royal Navy). RAF aircrew are selected on a strict anthropometric basis i.e. candidates for RAF aircrew must fit between maximum and minimum anthropometric dimensions and are, therefore treated as a separate population in their own right.

This dataset should be applied in the design of cockpits as well as aircrew clothing and equipment. Note the maintenance aspects of aircraft may have to take account of a wider target audience taking account of the full spectrum of the population defined in sections H.7 and H.8 above.

These data should not solely be used in the acquisition of equipment or capabilities which may be used by another service or sub-group of the population such as ground crew. Note that maintenance of aircraft, or use by other specific sub-sets of RAF population (e.g. ground crew) mean that other relevant datasets should also be referred to.

Table 29 – Anthropometric Data – Aircrew (Sample Size: 131)

Anthropometric Data - Aircrew (All Dimensions are provided in mm)					
Dimension	**3rd %ile**	**5th %ile**	**50th %ile**	**95th %ile**	**97th %ile**
1) Stature	1664	1686	1778	1901	1915
2) Eye height, standing	1583	1600	1686	1796	1814
3) Acromial height	1355	1362	1450	1555	1565
4) Elbow rest height, standing	1025	1034	1113	1192	1198
5) Foot Length	244	246	268	292	295
6) Bideltoid breadth	454	464	507	568	585
7) Biacromial breadth	328	344	388	428	434
8) Crotch height	754	766	825	904	918
9) Shoulder height, standing	1412	1414	1498	1612	1626
10) Hip breadth, standing	317	325	349	383	385
11) Waist (natural) circumference	715	739	863	1018	1049
12) Inter-elbow span	913	915	974	1068	1069
13) Buttock - Popliteal length	431	445	477	524	527
14) Buttock-knee length	560	568	607	656	671

Anthropometric Data - Aircrew (All Dimensions are provided in mm)					
Dimension	**3rd %ile**	**5th %ile**	**50th %ile**	**95th %ile**	**97th %ile**
15) Stomach depth (to wall)	240	243	284	334	347
16) Elbow functional reach	380	384	418	453	459
17) Elbow rest height, sitting	189	202	249	291	299
18) Vertical functional reach, sitting	1219	1247	1341	1418	1421
19) Functional reach (horizontal thumb tip reach), sitting	754	756	824	884	890
20) Sitting height	841	874	919	971	973
21) Eye height, sitting	757	762	819	876	881
22) Thigh clearance height	114	117	146	177	181
23) Stool height	375	378	417	462	470
24) Popliteal height	379	386	424	470	473
25) Knee height, sitting	489	492	529	595	599
26) Head length	191	195	205	217	218
27) Pupil to vertex	53	56	102	124	128
28) Head breadth	148	151	158	168	169
29) Hip breadth, sitting	346	349	382	413	416
30) Head circumference	553	557	584	610	612
31) Foot Breadth	83	85	96	107	108
32) Hand breadth	75	78	87	95	96
33) Hand length	176	178	197	216	218
34) Wrist circumference	149	156	173	192	193
35) Sitting shoulder height	586	593	643	682	683

Anthropometric Data - Aircrew (All Dimensions are provided in mm)					
Dimension	3rd %ile	5th %ile	50th %ile	95th %ile	97th %ile
36) Chest Depth	217	224	253	299	304
37) Interpupillary Distance	58	58	64	69	70
Weight (kg)	61	65	80	99	103

H.10 ANTHROPOMETRIC DATA - ROYAL NAVY – MALE

Table 30 provides anthropometric data for all Royal Navy (RN) males excluding Royal Marines. Royal Marines are considered to be a separate user group in their own right due to the strenuous selection and training regimes which tend to result in subtly different anthropometric properties from the rest of the Royal Navy. Data for the Royal Marines is provided below in section H.12.

This dataset should be applied in instances where a capability will be produced for use by the RN only. Examples of instances where these data may be applied include the design of RN clothing and equipment ensembles, ships, weapon systems and the design of facilities such as RN establishments.

These data should not solely be used in the acquisition of equipment or capabilities which may be used by another service or sub-group of the population such as the Royal Marines. Special consideration may have to be given to the anthropometrics of RM personnel operating on ships as a specific user group.

Table 30 – Anthropometric Data - Royal Navy – Male (Sample Size: 459)

Anthropometric Data - Royal Navy - Male (All Dimensions are provided in mm)					
Dimension	3rd %ile	5th %ile	50th %ile	95th %ile	97th %ile
1) Stature	1657	1667	1782	1892	1906
2) Eye height, standing	1549	1573	1678	1792	1804
3) Acromial height	1338	1352	1453	1563	1573
4) Elbow rest height, standing	1026	1035	1113	1204	1219
5) Foot Length	248	251	270	294	298
6) Bideltoid breadth	462	467	510	574	583
7) Biacromial breadth	350	353	389	435	442
8) Crotch height	739	749	830	918	930
9) Shoulder height, standing	1385	1404	1506	1611	1623
10) Hip breadth, standing	313	318	354	393	402
11) Waist (natural) circumference	728	748	883	1075	1118
12) Inter-elbow span	886	899	975	1063	1075
13) Buttock - Popliteal length	433	444	489	533	540
14) Buttock-knee length	560	567	617	662	672
15) Stomach depth (to wall)	228	237	292	356	379

Anthropometric Data - Royal Navy - Male (All Dimensions are provided in mm)					
Dimension	3rd %ile	5th %ile	50th %ile	95th %ile	97th %ile
16) Elbow functional reach	373	378	416	452	456
17) Elbow rest height, sitting	187	196	250	305	316
18) Vertical functional reach, sitting	1209	1231	1330	1444	1465
19) Functional reach (horizontal thumb tip reach), sitting	735	751	823	896	903
20) Sitting height	842	848	916	974	983
21) Eye height, sitting	741	750	812	880	895
22) Thigh clearance height	118	121	149	185	189
23) Stool height	371	374	413	453	460
24) Popliteal height	378	383	424	463	471
25) Knee height, sitting	490	495	536	596	604
26) Head length	188	190	202	214	216
27) Pupil to vertex	58	64	102	130	134
28) Head breadth	148	149	158	167	168
29) Hip breadth, sitting	332	338	380	417	425
30) Head circumference	550	551	578	605	610
31) Foot Breadth	87	89	100	111	113
32) Hand breadth	82	82	90	97	98
33) Hand length	177	180	198	218	220
34) Wrist circumference	149	154	173	192	197
35) Sitting shoulder height	582	589	640	696	701
36) Chest Depth.	210	216	256	302	315
37) Interpupillary Distance	58	59	64	70	71
Weight (kg)	61	64	83	106	111

H.11 ANTHROPOMETRIC DATA - ROYAL NAVY – FEMALE

Table 31 provides anthropometric data for all Royal Navy (RN) females (no females were included in the anthropometric survey of Royal marines as at the time of writing females cannot actively serve in the RM).

This dataset should be applied in instances where a capability will be produced for use by the RN only. Examples of instances where these data may be applied include the design of RN clothing and equipment ensembles, ships, weapon systems and the design of facilities such as RN establishments.

These data should not solely be used in the acquisition of equipment or capabilities which may be used by another service or sub-group of the population.

Table 31 – Anthropometric Data - Royal Navy – Female (Sample Size: 91)

Anthropometric Data - Royal Navy - Female (All Dimensions are provided in mm)					
Dimension	**3rd %ile**	**5th %ile**	**50th %ile**	**95th %ile**	**97th %ile**
1) Stature	1526	1536	1656	1778	1788
2) Eye height, standing	1442	1455	1569	1698	1706
3) Acromial height	1243	1259	1354	1466	1484
4) Elbow rest height, standing	959	968	1061	1143	1154
5) Foot Length	223	223	246	270	271
6) Bideltoid breadth	418	422	476	554	561
7) Biacromial breadth	294	298	339	381	386
8) Crotch height	712	729	799	876	894
9) Shoulder height, standing	1290	1300	1401	1495	1512
10) Hip breadth, standing	314	316	355	410	415
11) Waist (natural) circumference	651	677	797	961	981
12) Inter-elbow span	807	820	906	964	976
13) Buttock - popliteal length	416	427	476	516	521
14) Buttock-knee length	526	564	600	652	661
15) Stomach depth (to wall)	212	219	280	340	347

Anthropometric Data - Royal Navy - Female (All Dimensions are provided in mm)					
Dimension	3rd %ile	5th %ile	50th %ile	95th %ile	97th %ile
16) Elbow functional reach	339	347	380	413	421
17) Elbow rest height, sitting	194	203	248	294	301
18) Vertical functional reach, sitting	1110	1134	1221	1349	1365
19) Functional reach (horizontal thumb tip reach), sitting	676	692	758	819	828
20) Sitting height	770	780	843	911	914
21) Eye height, sitting	691	698	758	826	846
22) Thigh clearance height	113	116	141	174	176
23) Stool height	331	343	380	424	431
24) Popliteal height	346	350	381	421	423
25) Knee height, sitting	450	455	494	535	537
26) Head length	180	182	194	204	205
27) Pupil to vertex	44	49	84	117	118
28) Head breadth	141	142	152	166	166
29) Hip breadth, sitting	349	356	389	427	431
30) Head circumference	530	530	556	591	593
31) Foot Breadth	75	78	89	102	103
32) Hand breadth	70	71	78	85	86
33) Hand length	156	156	179	200	203
34) Wrist circumference	135	139	158	173	176
35) Sitting shoulder height	525	534	595	637	656
36) Chest Depth	202	209	251	309	313

Anthropometric Data - Royal Navy - Female (All Dimensions are provided in mm)					
Dimension	3rd %ile	5th %ile	50th %ile	95th %ile	97th %ile
37) Interpupillary Distance	56	57	61	66	66
Weight (kg)	49	51	70	93	96

H.12 ANTHROPOMETRIC DATA - ROYAL MARINES

Table 32 provides anthropometric data for the Royal Marines. Royal Marines are considered to be a separate user group in their own right due to the strenuous selection and training regimes which tend to result in subtly different anthropometric properties from the rest of the Royal Navy.

This dataset should be applied in instances where a capability will be produced for use by the RM. Examples of instances where these data may be applied include the design of RM clothing and equipment ensembles, ship living areas and small boats and landing craft, and the design of vehicles that may be specifically used by the RM.

These data should not solely be used in the acquisition of equipment or capabilities which may be used by another service or sub-group of the population.

Table 32 – Anthropometric Data - Royal Marines (Sample Size: 181)

Anthropometric Data - Royal Marines (All Dimensions are provided in mm)					
Dimension	3rd %ile	5th %ile	50th %ile	95th %ile	97th %ile
1) Stature	1682	1693	1781	1898	1910
2) Eye height, standing	1573	1582	1673	1785	1790
3) Acromial height	1366	1376	1455	1560	1566
4) Elbow rest height, standing	1034	1041	1119	1200	1209
5) Foot Length	250	254	269	289	291
6) Bideltoid breadth	471	479	516	562	571
7) Biacromial breadth	351	355	390	423	425
8) Crotch height	773	782	846	938	949
9) Shoulder height, standing	1419	1424	1507	1611	1630
10) Hip breadth, standing	315	319	344	374	380
11) Waist (natural) circumference	747	767	838	927	954
12) Inter-elbow span	878	887	979	1062	1073
13) Buttock - Popliteal length	442	444	483	526	529
14) Buttock-knee length	564	570	613	658	661
15) Stomach depth (to wall)	235	243	277	331	335

Anthropometric Data - Royal Marines (All Dimensions are provided in mm)					
Dimension	3rd %ile	5th %ile	50th %ile	95th %ile	97th %ile
16) Elbow functional reach	381	388	418	451	455
17) Elbow rest height, sitting	190	198	248	305	310
18) Vertical functional reach, sitting	1224	1230	1337	1434	1461
19) Functional reach (horizontal thumb tip reach), sitting	752	759	816	880	887
20) Sitting height	835	844	912	978	982
21) Eye height, sitting	735	745	807	867	880
22) Thigh clearance height	123	126	154	184	186
23) Stool height	368	373	413	454	458
24) Popliteal height	388	390	426	466	480
25) Knee height, sitting	503	504	538	600	605
26) Head length	191	192	200	210	210
27) Pupil to vertex	58	62	107	132	137
28) Head breadth	146	147	154	163	164
29) Hip breadth, sitting	334	338	372	400	407
30) Head circumference	556	558	575	598	598
31) Foot Breadth	89	90	99	108	108
32) Hand breadth	83	84	90	96	98
33) Hand length	177	180	196	214	217
34) Wrist circumference	157	159	172	188	189
35) Sitting shoulder height	581	588	641	698	702
36) Chest Depth	223	226	248	281	282

Anthropometric Data - Royal Marines (All Dimensions are provided in mm)					
Dimension	3rd %ile	5th %ile	50th %ile	95th %ile	97th %ile
37) Interpupillary Distance	58	59	64	69	70
Weight (kg)	67	69	81	96	97