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4.22.2 Signs. Verify that any physical hazards that cannot use protective devices are identified by type with a plainly visible warning sign.

4.23 Electrical ground. On the exterior trailer frame locate and verify an electrical ground for the arc welding source and all electrical circuits, attached to the trailer frame by not less than a ¼ inch diameter grounding stud and wing nut. Confirm that it is clearly marked and no more than 3 feet from ground level.

4.24 Stability. Put the TMWSS in an operational mode, support legs not in use, place a 200 pounds load on the work surface. The TMWSS shall remain level and not tilt.

4.24.1 Center of gravity. Under any two wheels that define the front, back, left side or right side of the TMWSS place jacks. Using the two jacks simultaneously lift the side not less than 15° from the horizontal. The TMWSS shall not tilt over. Lower the TMWSS and repeat on the remaining three sides. Tilting over on any side will be cause for rejection.

4.25 Component restraints. During the center of gravity tests, and when in the 15° degree raised position, all TMWSS stowed components, all drawers, and all doors must remain in their restrained position. Any falling out or sliding from a restrained position of any TMWSS component shall be cause for rejection.

4.26 Welding curtains. With the TMWSS in an operational mode, demonstrate the enclosure can secure welding curtains around the workbench and they have clear space above and below to prevent the accumulation of noxious fumes.

4.27 Noxious fumes. With the TMWSS in an operational mode, start the arc welder power source. Verify its exhaust fumes are vented away from the workbench and will not become a hazard.

4.28 Transportability. Provide an analysis showing that the TMWSS in its towing or storage mode is suitable for commercial shipping via air, sea, rail, or highway.

4.28.1 Shock and vibration. The TMWSS shall be tested in accordance with MIL-STD-810, Method 516.4, Procedure VIII - Rail Impact. The TMWSS shall be in transport and storage mode for the test, with all items in their storage locations and all doors and panels closed and locked. Inability to operate the arc welding power source or air compressor following the test; binding of any door or panel; dislodgment of or damage to any stored item; or damage to any part of the enclosure shall be cause for rejection.

4.28.2 Lifting and tie down. Verify the required locations, strengths, clearances, and labeling of all lifting and tie down provisions in accordance with MIL-STD-209. Examine the enclosure and

identify the integral spreader bar(s), if any.

4.28.3 Military towing. Prepare the TMWSS for towing and demonstrate its ease and capability for towing with another military vehicle.

4.29 Weight. Weigh a fully loaded TMWSS. It shall not be greater than 4200 pounds.

4.30 Ground clearance. With a fully loaded TMWSS on level ground, measure its ground clearance. It shall not be less than 16 inches.

4.31 Balance. Put the TMWSS in a storage mode and obtain its total weight. Measure the weight reaction under each wheel and calculate the center of gravity (CG) which must be within 3 inches of the longitudinal centerline of the TMWSS. (see paragraph 3.8.3) Repeat, measuring the weight reaction at the pintle and then on the longitudinal axis at rear end of the TMWSS. Calculate the CG which must be forward of the trailer axle. The pintle weight must be not less than 5% or greater than 15% of the initial measured weight.

4.32 Roadability. The TMWSS shall be driven 600 miles on a Secondary Road course; 1200 miles on a Cross Country course; 200 miles on a Belgian Block course and 5 laps around a Road Shock and Vibration Course (see 6.9.5). Any evidence of damage to the enclosure, including loose or missing fasteners, any damage to, or displacement of, any component, accessory, part, or tool installed in or on the TMWSS, or the failure of any item of equipment in the TMWSS to function properly upon completion of the course shall be cause for rejection.

4.32.1 Speed. Speed shall be not less than 45 miles per hour (mph) on the Secondary Road course. For all other road courses the speed shall vary between 15-35 mph.

4.33 Durability. The TMWSS shall have a projected economic life of not less than 10 years. The contractor shall provide a report detailing this projected economic life. The projection may be made based on historical data regarding the economic life of items having similar design and manufacture, test data, or a combination thereof. Lack of supportive objective evidence in the report shall be cause for rejection.

4.34 Ease of maintenance.

4.34.1 Access. Using operators meeting the anthropometry requirements of Appendix A (see A5.1.1) demonstrate that all routine maintenance tasks (see 3.10.1) can be performed without removing the arc welding source from the trailer.

4.34.2 Fastening devices. Examine all removable fasteners on the TMWSS and verify that all use some means of keeping tightness and none are staked, swaged, or otherwise deformed.

4.34.3 Cleaning. Within the TMWSS locate all points that may become collection points for cleaning fluid and verify each has a drain port.

NBC decontamination. Provide an analysis that the TMWSS's enclosure meets this military unique requirement. At a minimum the analysis shall include verification that materials used do not absorb biological or chemical agents and they shall not be damaged by steam or strong cleaning agents used for decontamination. Tool, equipment and expendable supplies loaded in the enclosure need not be NBC contamination survivable.

4.36 Protective finish. Confirm that all metal parts of the TMWSS's trailer and enclosure have a protective finish in accordance with MIL-STD-171, finish 7.3.1 plus 20.24 (CARC) for aluminum and finish 5.1.1 plus 20.24 for ferrous metals.

5. PACKAGING

5.1. Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see paragraph 6.2). When actual packaging of materiel is to be performed by DOD personnel, these personnel need to contact the responsible packaging activity to ascertain requisite packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activity within the Military Department or Defense Agency, or within the Military Department's System Command. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1. Intended use. The TMWSS is intended for use by personnel engaged in the maintenance and repair of military equipment while away from fixed maintenance facilities.

6.2. Ordering data.

6.2.1. Acquisition requirements. Acquisition documents must specify the following:

- a. Title, number, and date of this specification.
- b. The issue of the DoDISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see paragraphs 2.2 and 2.3).
- c. First article, when required (see paragraph 3.1).
- d. Color, if different, including camouflage pattern as appropriate (see paragraph 3.5.3).

e. Packaging requirements (see paragraph 5.1).

6.2.2. Supplementary data. The contracting officer should arrange to furnish supplementary information as needed concerning items specified in the Components List (see paragraph 3.2).

6.2.3. Government furnished materiel. The contracting officer must arrange for delivery of the required quantity of Trailer, Cargo: 2840 Pounds, 2-Wheel M1102, NSN 2330-01-387-5426 (see paragraph 3.3.1).

6.2.4. Provisions. The contracting officer should include provisioning requirements for repair parts and maintenance tools as necessary (including any special tools), and instructions on shipment as shops.

6.2.5. Technical manuals. The requirement for technical manuals should be considered when this specification is applied on a contract. If technical manuals are required, specifications and standards that have been cleared and listed in DOD 5010.12-L, Acquisition Management Systems and Data Requirements Control List (AMSDL), must be listed in a separate Contract Data Requirements List (DOD Form 1423), which is included as an exhibit to the contract. The technical manuals must be acquired under a separate line item in the contract.

6.2.6. First article. When a first article inspection is required, the TMWSS(s) provided for inspection shall be a first article sample, a first production item, a sample selected from the first run of production items, or a standard production item from the contractor's current inventory, as specified in 4.2.1. The contracting officer should include specific instructions in the acquisition documents regarding the specific number of units to undergo first article inspection, the arrangements for examination, approval of first article test results, and disposition of first article units. Invitations for bid should provide that the Government reserves the right to waive the requirement for first article inspection for those bidders offering products which have been previously acquired or tested by the Government; and that bidders offering such products who wish to rely on such prior acceptance or test must furnish evidence with the bid that prior Government approval is presently appropriate for the pending contract.

6.3. Fuel. When in military service, the arc welding power source will operate on diesel fuel oil blended and refined to meet specific government operational requirements. The fuel used will most likely conform to Federal Specification VV-F-800, Grades DL-1 (Winter Grade), and DL-2 (Standard Grade). The diesel fuel oils cited by this specification for use in the welding power source are generic commercial-grade fuels similar enough to DL-1 and DL-2 to make them acceptable substitutes for use in testing. The contractor is cautioned that the properties of diesel fuels are tailored for the season and climatic region where they are to be used. It is the contractor's responsibility to assure that the fuel used in testing is appropriate for the test conditions.

6.4. Noise limits. The requirement for posting Noise Hazard signs on all equipment generating noise in excess of 85 dB (A) supports the Army Hearing Conservation Program (see DA PAM

40-501). The Army program requirement is more conservative than the standard OSHA requirement, which sets the threshold criterion at 90 dB (A) for an 8 hour exposure. If technically and economically feasible, it is preferred that the noise level of the TMWSS not exceed 85 dB (A). This is an Army unique requirement.

6.5. Trailer lights and reflectors. The lights and reflectors required for military tactical trailers are generally identical to those required by Federal Motor Vehicle Safety Standards (FMVSS), except that the combination tail and stop light assemblies contain blackout lights on a separate circuit. This is a military-unique requirement.

6.6. Padlocks. The locks specified herein are in accordance with the recommendations of Army Regulation (AR) 190-51, "Security of Army Property at Unit and Installation Level."

6.7. Measurement system. The US Customary System of Units (US) or the International System of Units (SI) may be used in construction of the TMWSS. In this specification, all measurements, dimensions, sizes, and capacities are given in the US system. These measurements may be converted to the SI system by using the conversion factors and methods specified in ASTM E380.

6.8. Recycled, recovered, or environmentally preferable materials. Recycled, recovered or environmentally preferable materials *should be used to the maximum extent possible provided the material meets or exceeds the operational and maintenance requirements, and promotes economically advantageous life cycle costs.*

6.9. Definitions.

6.9.1. Displacement. Displacement is dislodgment of any tool or item of equipment from its designated position. Movement of a tool or item of equipment within its designated position without any dislodgment is permitted.

6.9.2. Extent practical. Where it appears within this document, the phrase, "to the extent practical," indicates a product characteristic that is desired, but that cannot be quantified without addressing a specific design. The degree to which the product offered possesses these characteristics will be used by the government as a basis for assessing its value relative to that of products offered by other bidders.

6.9.3. Fully loaded. The shop set is fully loaded when it is completely equipped and ready for operation. In addition to the full compliment of items on the components list, the power unit is filled with fuel, lubricant, and coolant; and the enclosure contains the full compliment of expendable supplies, including filled propylene and gas cylinders. In the opposite (unloaded) condition, all equipment that is normally affixed to the trailer or enclosure when in use, such as the arc welding power unit, remains on the trailer, but the gas cylinders and all other stored items have been removed.

6.9.4. Secured cargo. Secured cargo is cargo that is securely tied or blocked in all three axes with respect to the bed of the transport vehicle.

6.9.5. Vehicle test courses. The road types specified in 6.9.5.1 through 6.9.5.4 below refer to those provided by the Automotive Test Facilities at Aberdeen Proving Ground, Aberdeen,

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Maryland. The road definitions are descriptive in nature and apply to test courses considered standard. Alternate test courses, such as those located at the U.S. Army Yuma Proving Ground or approved contractor facilities, may be utilized.

6.9.5.1. Secondary road course. Secondary roads consist of gravel roads and dirt trails with level or rolling contours, moderate washboard and rutting, and occasional potholes.

6.9.5.2. Cross-country terrain. Cross-country terrain consists of unimproved open ground, including hills and fields. The course consists of native loam, gravel, and rock. Surface conditions range from moderate to rough.

6.9.5.3. Belgian Block course. The course consists of a road paved with unevenly laid granite blocks forming an undulating surface, which duplicates the cobblestone roads found in many parts of the world.

6.9.5.4. Road shock and vibration course. The course consists of several segments representing different rough road conditions; two-inch washboard (822 ft), two-inch to four-inch radial washboard (243 ft), three-inch spaced bump (764 ft), and six-inch washboard (798 ft).

6.9.6. Acquisition instrument identification number: The Government acquiring activity's contract or purchase order number.

6.9.7. Part or Identifying Number (PIN): The identifier assigned by the manufacturer, which uniquely identifies the TMWSS relative to the manufacturer; often a model number or top assembly drawing number.

6.9.8. Commercial and Government Entity (CAGE) Code: a five-character code which is assigned to commercial and Government activities that manufacturer or develop items, or provide services or supplies to the Government. The CAGE was previously called the manufacturer's code, code identification number, or Federal Supply Code for Manufacturers (FSCM).

6.9.9. NATO Supply Code for Manufacturers (NSCM): A five-position alpha-numeric code assigned to manufacturers that are located in a country other than the United States or Canada, and are a source of supply for items acquired by the Federal Government, NATO member nations, and other participating friendly Governments.

6.10. Subject terms (key word) listing.

- Environmental
- Roadability
- Shop Set
- Tools and equipment
- Welding

6.11. Acronyms in this specification. The acronyms used in this specification are:

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DoD	- Department of Defense
DoDISS	- Department of Defense Index of Specifications and Standards
GVW	- Gross Vehicle Weight
GVWR	- Gross Vehicle Weight Rating
LIN	- Line Item Number
NSN	- National Stock Number
TMWSS	- Trailer Mounted Welding Shop Set

Custodian:
Army - AL

Preparing Activity:
Army - AL

TABLE I. Requirement/verification matrix

		<u>Verification Methods</u>					<u>Verification Class</u>			
		N - Not Applicable					A = First Article			
		1 - Analysis					B = Conformance			
		2 - Demonstration								
		3 - Examination								
		4 - Test								
Title	Section 3 Requirement	Verification Method					Verification Class		Section 4 Requirement	
		N	1	2	3	4	A	B		
Performance	3.2				X		X	X	4.5	
Arc welding process	3.2.1			X			X	X	4.6	
Oxy-fuel gas welding	3.2.2			X			X	X	4.6.1	
Compressed air	3.2.3			X			X	X	4.6.2	
Operational distance	3.2.4			X			X	X	4.7	
Work surface	3.2.5.1				X		X	X	4.8.2	
Shelter	3.2.5.2				X		X	X	4.8.2	
Vise	3.2.5.3				X		X	X	4.8.3	
Strength	3.2.5.4					X	X	X	4.8.3.1, 4.8.4	
Lighting	3.2.5.5					X	X		4.8.5	
Trailer	3.3.1				X		X	X	4.9.1	
Trailer modification	3.3.1.1				X		X	X	4.9.1.1	
Lights and reflectors	3.3.1.2				X		X	X	4.9.2	
Size	3.3.2				X		X		4.10	
Human interface	3.3.3			X			X		4.11	
Task loading	3.3.3.1			X			X		4.11	
Protective clothing	3.3.3.2			X			X		4.11.1	
Easy access	3.3.3.3.1			X			X		4.11.1	
Free movement	3.3.3.3.2			X			X		4.12	
Organized storage	3.3.3.3.3				X		X		4.13.1	

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Proximate storage	3.3.3.3.4				X		X		4.13.1
Linear products	3.3.3.3.5				X		X		4.13.2
Visual cues	3.3.3.3.6				X		X	X	4.13.1
Rapid inventory	3.3.3.3.7			X			X		4.13.3
Plates and labels	3.3.4				X		X	X	4.14
Item identification	3.3.4.1				X		X	X	4.15
Shipping data	3.3.4.2				X		X	X	4.15.1
Hazard identification	3.3.4.3				X		X	X	4.15.2
Noise hazards	3.3.4.3.1				X	X	X		4.16
Lift hazards	3.3.4.3.2				X		X	X	4.17
Operational environment	3.4.1					X	X		4.18.1, 4.18.2
Operating temperatures	3.4.1.1					X	X		4.18.1, 4.18.2
Storage environment	3.4.2					X	X		4.18.3, 4.18.4
Storage temperatures	3.4.2.1					X	X		4.18.3, 4.18.4
Weather protection	3.4.2.2					X	X		4.18.5, 4.18.5.1
Fungus and moisture	3.4.3		X				X		4.18.6
Ozone	3.4.4		X				X	X	4.18.7
Storage restraints	3.4.5				X	X	X	X	4.19, 4.28.1
Enclosure	3.5				X		X	X	4.19
Storage	3.5.1				X		X	X	4.19
Locks	3.5.2.1				X		X	X	4.20.1, 4.20.1.1
Anti-tempering measures	3.5.2.2				X		X	X	4.20.2
Loss and damage prevention	3.5.2.3				X		X	X	4.20.3
Protective coloration	3.5.3				X		X	X	4.21
Physical hazard control	3.6.1				X		X	X	4.22.1, 4.22.2
Physical strain control	3.6.2				X		X	X	4.22.1, 4.22.2
Electrical ground	3.6.3				X		X	X	4.23

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Stability	3.6.4				X		X		4.24, 4.24.1
Component restraints	3.6.5				X		X	X	4.25
Welding curtains	3.6.6				X		X	X	4.26
Noxious fumes	3.6.7				X		X	X	4.27
Transportability	3.7			X			X	X	4.28
Shock and vibration	3.7.1			X			X		4.28.1
Lifting and tie down provisions	3.7.2				X		X	X	4.28.2
Towing	3.8			X			X		4.28.3
Weight	3.8.1				X		X	X	4.29
Ground clearance	3.8.2				X		X		4.30
Balance	3.8.3			X			X		4.31
Roadability	3.8.4					X	X		4.32, 4.32.1
Durability	3.9		X				X		4.33
Access	3.10.1			X			X		4.34.1
Fastening devices	3.10.2			X			X	X	4.34.2
Cleaning	3.10.3				X		X		4.34
Decontamination	3.10.4		X				X		4.35
Protective finish	3.10.5				X		X	X	4.36

APPENDIX A HUMAN ENGINEERING DESIGN CRITERIA

A1. SCOPE

A1.1. Scope. This appendix establishes specific human engineering design criteria for the TMWSS. The requirements in this appendix represent a tailored version of MIL-STD-1472, which is the Army's general design standard for Human Engineering. This appendix is a mandatory part of this specification.

A1.2. Purpose. The purpose of this appendix is to present human engineering design criteria, principles, and practices to achieve mission success through integration of the human into the TMWSS and achieve effectiveness, simplicity, efficiency, reliability, and safety of TMWSS operation and maintenance.

A1.3. Application. This appendix shall be applied to the design of the TMWSS. It is not required to be applied to off-the-shelf items selected for incorporation into the TMWSS, except as specifically noted herein. Nothing in this appendix shall be construed as limiting the selection of hardware, materials, or processes to the specific items described herein.

A1.4. General. This appendix does not alter requirements for participation of human engineering specialists in development of the TMWSS to interpret and implement these practices and to provide solutions to human engineering problems which arise and which are not specifically covered herein.

A1.5. Manufacturing tolerances. When manufacturing tolerances are not perceptible to the user, this appendix shall not be construed as preventing the use of components whose dimensions are within a normal manufacturing upper or lower limit tolerance of the dimensions specified herein.

A2. APPLICABLE DOCUMENTS

The documents cited in this section are for reference only, and do not constitute a part of this standard. They are provided as a source of additional information.

HANDBOOKS

DEPARTMENT OF DEFENSE

DOD-HDBK-743	-	Anthropometry of US Military Personnel
MIL-HDBK-759	-	Human Factors Engineering Design for Army Materiel
MIL-HDBK-1908	-	Definitions of Human Factors Terms

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Standardization Documents Order desk, 700 Robbins Avenue, Bldg 4D, Philadelphia, PA 19111-5094.)

A3. DEFINITIONS

Unless otherwise specified, terms are defined in accordance with MIL-HDBK-1908.

A4. GENERAL REQUIREMENTS

A4.1. Objectives. The TMWSS shall provide work a environment which fosters effective procedures, work patterns, and personnel safety and health, and minimizes factors which degrade human performance or increase error. Design shall also minimize personnel and training requirements within the limits of time, cost, and performance trade-offs.

A4.2. Standardization. Criterion for selecting off-the-shelf commercial equipment shall include the degree to which the equipment conforms to this standard. Where off-the-shelf equipment requires modification in order to interface with other equipment, the modification shall be designed to comply with the criteria herein. Redesign or modification of off-the-shelf commercial equipment for the sole purpose of complying with the requirements of this Appendix must have the approval of the procuring activity.

A4.3. Function allocation. Design shall reflect allocation of functions to personnel, equipment, and personnel-equipment combinations to achieve: a. required time and safety, b. minimum number and level of skills of personnel required to operate and maintain the TMWSS, and c. required performance in a cost-effective manner.

A4.4. Human engineering design. Design shall reflect human engineering and biomedical factors that affect human performance, including, when applicable: a. protection from thermal, toxicological, mechanical, electrical, electromagnetic, visual, and other hazards; b. adequate space for personnel, their equipment, and free volume for the movements and activities they are required to perform during operation and maintenance tasks under both normal and emergency conditions; c. adequate physical, visual, auditory, and other communication links between personnel and their equipment under both normal and emergency conditions; d. efficient arrangement of operation and maintenance workplaces, equipment, controls, and displays; e. design features to assure rapidity, safety, ease and economy of operation and maintenance; f. compatibility of the design, location and layout of controls, workspaces, maintenance accesses, stowage provisions, allocated tasks, and control movements with the clothing and personal equipment to be worn by personnel operating and maintaining the TMWSS.

A4.4.1. Safety. Design shall reflect applicable system and personnel safety factors, including minimizing potential human error in the operation and maintenance of the TMWSS.

A4.4.2. Layout. Units shall be laid out so that a minimum of place-to-place movements will be required during operation.

A4.4.3. NBC survivability. The TMWSS shall permit performance of mission-essential operations, maintenance, and decontamination tasks by suitably clothed, trained, and acclimatized personnel for the NBC environments required by the system.

A4.4.4. Simplicity of design. The equipment shall represent the simplest design consistent with functional requirements and expected service conditions. It shall be capable of being operated, maintained, and repaired in its operational environment by personnel with a minimum of training.

A5. DETAILED REQUIREMENTS

A5.1. Anthropometry.

A5.1.1. General. Design and sizing shall ensure operability and maintainability by the user population. Generally, design limits shall be based upon a range from the 5th percentile female to the 95th percentile male values for critical body dimensions, as appropriate. This design range from the 5th

to 95th percentile values will theoretically provide coverage for 90 percent of the user population for that dimension. **NOTE:** The data provided herein are intended for use as individual (stand-alone) parameters, which should be adequate to support design of the TMWSS. However, the relationships or correlations between body measurements are highly variable. If two or more dimensions are used simultaneously as design parameters, they cannot be assumed to be additive; appropriate multivariate data and techniques must be utilized. Simultaneous use of two or more anthropometric dimensions as a design parameter shall require approval of the procuring activity.

A5.1.2. Anthropometric data. Anthropometric data for the design and sizing of workspaces involving the standing position are presented in Table 1 and illustrated in Figure 1. Fifth and 95th percentile values are given for various body dimensions. Suitable allowances should be made for heavy clothing or protective equipment when required. Clearance dimensions shall be not less than the 95th percentile values for men; limiting dimensions shall be not more than the 5th percentile values for women, shown in Table I. The intended user population for the TMWSS consists of Metal Workers, Military Occupational Specialty (MOS) 44B. Metal Workers are required to possess greater physical strength than the general population, and the criteria herein have been adjusted accordingly.

A5.1.3. Use of Data. Use of these data shall consider (a) the nature, frequency, safety, and difficulty of the related tasks to be performed by the operator of the equipment; (b) the position of the body during performance of these tasks; (c) mobility or flexibility requirements imposed by these tasks; and (d) increments in the design-critical dimensions imposed by the need to compensate for obstacles and projections.

A5.1.4. Adjustments. Because the above-cited anthropometric data represent light clothing measurements, suitable allowances in design-critical dimensions shall be made for heavy clothing, protective equipment, and other worn or carried items when utilizing these data for design criteria.

A5.1.5. Clearance dimensions. Clearance dimensions (e.g., for accesses), which must accommodate or allow passage of the body or parts of the body, shall accommodate the 95th percentile values for applicable body dimensions.

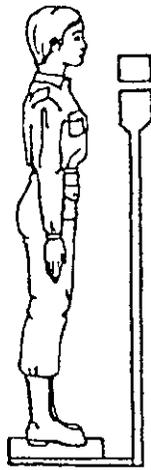
A5.1.6. Limiting dimensions. Limiting dimensions (e.g., reaching distance, control movement, displays, test points) which restrict or are limited by extensions of the body shall accommodate the 5th percentile values for applicable body dimensions.

A5.1.7. Control and Display placement. All controls and visual displays mounted on vertical panels and used in normal equipment operation shall be mounted 86 - 178 cm (34 - 70 in) above the standing surface.

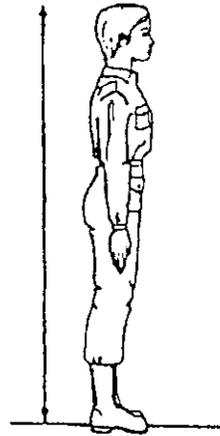
TABLE I. Anthropometric data for clothed personnel, standing position

	Percentile Values in Centimeters (Inch equivalents in Parentheses)*			
	5 th Percentile		95 th Percentile	
	Men	Women	Men	Women
1. Weight (Fig. 1)	65.2 Kg (143 lbs)	50 Kg (110 lbs)	101.7 Kg (224 lbs)	80.6 Kg (177 lbs)
2. Stature (Fig. 1)	168.3 (66.3)	156.2 (61.5)	190.9 (75.2)	177.5 (69.9)
3. Eye height (Fig. 2)	156.6 (61.7)	145.3 (57.2)	178.1(70.1)	165.9 (65.3)
4. Shoulder (Acromiale) height (Fig. 2)	138.0 (54.3)	126.8 (49.9)	158.4 (62.4)	147.0 (57.9)
5. Chest (Nipple) height (Fig. 2)	122.4 (48.2)	112.7 (44.4)	141.1 (55.6)	131.1 (51.6)
6. Elbow (Radiale) height (Fig. 2)	106.1 (41.8)	99.9 (39.3)	123.7 (48.7)	114.8 (45.2)
7. Fingertip (Dactylion) height (Fig. 2)	62.9 (24.8)	58.9 (23.2)	76.2 (30.0)	70.8 (27.9)
8. Waist (Iliocristale) height (Fig. 2)	99.1 (39.0)	94.9 (37.4)	119.7 (47.1)	110.9(43.7)
9. Crotch height (Fig. 2)	79.1 (31.1)	71.9 (28.3)	95.6 (37.6)	88.4 (34.8)
10. Knee (Mid-Patella) height (Fig. 2)	49.9 (19.6)	45.5 (17.9)	59.0 (23.2)	54.1 (21.3)
11. Functional (Thumbtip) reach (Fig. 3)	71.7 (28.2)	67.7 (26.7)	88.6 (34.9)	80.5 (31.7)
12. Functional reach, extended (Fig 3)	80.5 (31.7)	73.5 (28.9)	94.2 (37.1)	92.3 (36.3)
13. Overhead reach height (Fig. 3)	200.4 (78.9)	185.3 (73.0)	230.5 (90.8)	215.1 (84.7)

* Data derived from MIL-HDBK-759, Table 16a. Weights were adjusted from nude body by adding 3.61 kgs (7.97 lbs) for Battle Dress Uniform, underwear, belt and boots. Heights were adjusted from nude body by adding 3.81 cm (1.5 in) for combat boot heel.



① WEIGHT (CLOTHED WEARING FATIGUES & COMBAT BOOTS; STANDING IN CENTER OF SCALE)



② STATURE (CLOTHED) STANDING ERECT; HEELS TOGETHER; WEIGHT DISTRIBUTED EQUALLY ON BOTH FEET. MEASURED FROM STANDING SURFACE TO TOP OF HEAD

FIGURE 1. Anthropometric data for the standing position, weight and stature

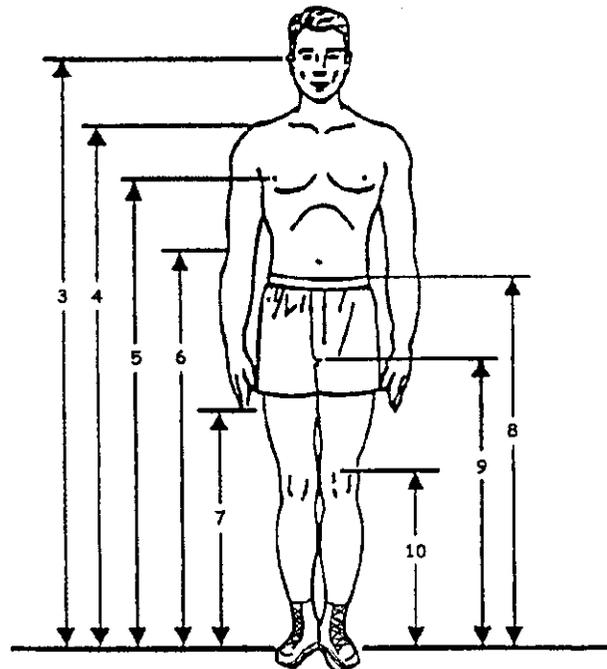
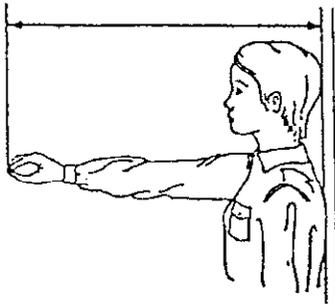
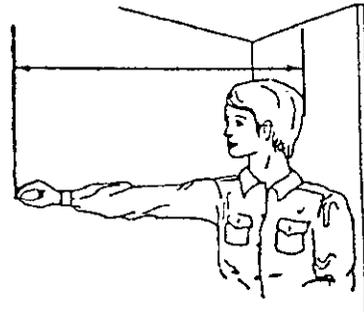


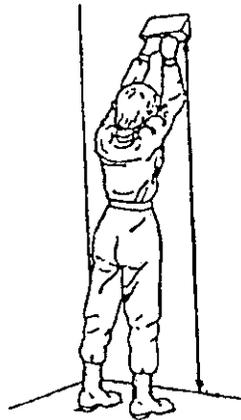
FIGURE 2. Standing body dimensions



⑪ FUNCTIONAL REACH - STANDING ERECT; LOOKING STRAIGHT AHEAD; BOTH SHOULDERS AGAINST WALL; RIGHT ARM HORIZONTAL. MEASURED FROM WALL TO TIP OF THUMB.



⑫ FUNCTIONAL REACH, EXTENDED - STANDING ERECT; LOOKING STRAIGHT AHEAD; RIGHT SHOULDER EXTENDED AS FAR FORWARD AS POSSIBLE WHILE BACK OF LEFT SHOULDER FIRMLY AGAINST WALL; ARM HORIZONTAL. MEASURED FROM WALL TO TIP OF THUMB.



⑬ OVERHEAD REACH HEIGHT - STANDING WITH HEELS 23 cm APART AND TOES 15 cm FROM WALL; ARMS EXTENDED OVERHEAD WITH FISTS TOUCHING AND AGAINST WALL; 1st PHALANGES HORIZONTAL. MEASURED FROM FLOOR TO HIGHEST POINT ON 1st PHALANGES

FIGURE 3. Standing reach

A5.2. Body movement.

A5.2.1. Range of motion. Table 2 gives the ranges, in angular degrees, for all voluntary movements the joints of the body can make, as illustrated in Figure 4. The designer should remember that these are maximum values; since they were measured with nude personnel, they do not reflect the

restrictions clothing would impose. The lower limit should be used when personnel must operate or maintain an item; the upper limit should be used in designing for freedom of movement.

A5.2.2. Whole body. All operating positions should allow enough space to move the trunk of the body. When large forces [more than 13.6 kg (30 lbs)] or large control displacements [more than 380 mm (15 in) in a fore-aft direction] are required, the operator should have enough space to move his entire body.

TABLE II. Range of human motion¹

Body Member	Movement	Lower Limit (degrees)	Average (degrees)	Upper Limit (degrees)
A. Wrist	1. Flexion	78	90	102
	2. Extension	86	99	112
	3. Adduction	18	27	36
	4. Abduction	40	47	54
B. Forearm	1. Supination	91	113	135
	2. Pronation	53	77	101
C. Elbow	1. Flexion	132	142	152
D. Shoulder	1. Lateral Rotation	21	34	47
	2. Medial Rotation	75	97	119
	3. Extension	47	61	75
	4. Flexion	176	188	190
	5. Adduction	39	48	57
	6. Abduction	117	134	151
E. Hip	1. Flexion	100	113	126
	2. Adduction	19	31	43
	3. Abduction	41	53	65
	4. Medial Rotation (prone)	29	39	49
	5. Lateral Rotation (prone)	24	34	44
	6. Lateral Rotation (sitting)	21	30	39
	7. Medial Rotation (sitting)	22	31	40
F. Knee Flexion	1. Prone	115	125	135
	2. Standing	100	113	126
	3. Kneeling	150	159	168

¹These values are based on the nude body. The ranges are larger than they would be for clothed personnel.