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Materiel Test Procedure 8-3-509
U. S. Army Infantry Board

U. S. ARMY TEST AND EVALUATION COMMAND
COMMON SERVICE TEST PROCEDURE

HUMAN FACTORS ENGINEERING

1. OBJECTIVE

The objective of this materiel test procedure is to describe the service test procedures required to determine the adequacy of the Human Factors Engineering (HFE) aspects of Chemical-Biological (CB) equipment and its compatibility with the skills, aptitudes and limitations of the military personnel.

2. BACKGROUND

HFE is the application of scientific principles concerning human physical and psychological characteristics to the design of equipment, so as to increase speed and precision of operations, provide maximum maintenance efficiency, reduce fatigue, and simplify operations. HFE requires the consideration of human characteristics such as anthropemetrics (the study of human body measurements on a comparative basis), intellectual abilities, sensory capacities, mobility, muscle strength, basic skills and the capacity to learn new skills.

The evaluation of HFE plays a major role in the conduct of a service test. Each man-machine relationship must be carefully observed, to determine the efficiency and ease of operation, creature comfort, and limitations, when the test item is employed by a representative soldier in a simulated combat environment.

3. REQUIRED EQUIPMENT

Human factors evaluations normally will require no special tools or test equipment other than those normally accompanying the test item. Specific selections shall be made by the test officer and the human factors engineer based on the particular test item.

4. REFERENCES

A. HEL-STD S-1-63 (B), Maximum Noise Level for Army Materiel Command Equipment, 1965.
B. HEL-STD S-4-65, Human Factors Engineering Requirements for the Development of U. S. Army Materiel, 1965.
C. Report of Human Factors Engineering Seminar, (presented for U. S. Continental Army Command) Dunlap and Associates, Inc., 429 Atlantic Street, Stamford, Connecticut, 1960.
D. Woodson, Wesley E., and Conover, Donald W., Human Engineering Guide for Equipment Designers, Second Edition, University of California Press, 1966.
E. Morgan, Chapanis, Cook and Lund, Human Engineering Guide

to Equipment Design, McGraw-Hill Book Co., 1963. (Sponsored by Joint Army-Navy-Air Force Steering Committee).

F. MTP 7-3-511, Air Drop Operations - Personnel and Individual Equipment.
G. MTP 8-1-001, Testing Chemical, Biological and Radiological Equipment.
H. MTP 8-3-502, Battlefield Mobility.
I. MTP 8-3-506, Safety.
J. MTP 10-1-002, Field Combat Test Exercises.

5. SCOPE

5.1 SUMMARY

The areas of consideration relative to HFE designated in this MTP will aid in the evaluation of the overall man-machine relationship when the CB test item is employed by the soldier in a combat environment. As a result of observations, examinations, and measurements of specific design features, supplemented by the opinions of test soldiers, the test officer can arrive at a conclusion relative to soldier efficiency when operating the test item and identify any problem areas incident thereto.

During the service test of a CB test item, a specific subtest relative to HFE ordinarily is not conducted per se. Data are collected from each subtest of the commodity service testing as they relate to human factors. These facts are then evaluated and serve as the basis for a conclusion.

A list of the subtests during which determination of the degree to which the item under test conforms to accepted human factors design principles, and the suitability of the design at man-machine interfaces, is given as follows:

a. Personnel - Determines:

1) Whether the test soldiers are representative of the soldier in the field, (are they in the 5th or 95th percentile group).
2) The status of their military MOS and combat training.
3) Their attitude toward the test.
4) The application of anthropometrics as appropriate.

b. Instructional Aspects - Determines:

1) The clarity and adequacy of the instructional material.
2) The ability of the test soldier to absorb training relative to assembly and disassembly, operation, and maintenance.

c. Battlefield Mobility - Determines the ease with which a soldier(s) can move the equipment around the combat area and considers:

1) The relationship of the test soldier(s) to the physical characteristics of the item weight, dimensions, configuration, center of balance).
2) The ability of the test soldier(s) to man-transport the item over all types of terrain.
3) The ability of the parachutist to execute a jump while carrying the equipment.
4) The ability of test soldier(s) to transport the item using applicable air and land vehicles.

d. Operational Aspects - Determines:

1) The man-machine relationship relative to the ease of operation under different environmental conditions when test soldier(s) are equipped with appropriate clothing.
2) HFE factors which may contribute to less efficient operation.

e. Maintenance Aspects - Determines the HFE aspects relative to the ease with which maintenance can be conducted.

f. Special Considerations for CB Equipment - Determines the HFE effects produced by the peculiar characteristics of the CB test item.

NOTE: Since CB equipment encompasses many different types of items (as defined in MTP 8-1-001, Testing Chemical, Biological and Radiological Equipment), each having its own HFE aspects of the man-machine relationship, it has been categorized for convenience of evaluation in Appendix C.

5.2 LIMITATIONS

The procedures given in this Materiel Test Procedure are applicable only to items classified as CB equipment and are necessarily limited to those general human factors consideration which can be quite easily measured and assessed. No attempt is made to present tests and experimental procedures for the measurement and analysis of the dynamic processes affecting operability and efficiency of a particular man-machine system. Such tests and experiments must be designed by a qualified human factors engineer for the particular equipment or system under test.

6. PROCEDURES

6.1 PREPARATION FOR TEST

a. Prior to the start of operational testing, the test officer and

the test agency's human factors specialist shall perform a system and task analysis (see Appendix A) in such detail as required by the nature and complexity of the test item. Sufficient narrative comments shall be recorded pertaining to training, logistical requirements and statistical considerations to provide background information to be used in the analysis of test results.

b. Ensure that all test personnel are familiar with the required technical and operational characteristics of the item under test, such as stipulated in Qualitative Materiel Requirements (QMR), Small Development Requirements (SDR), and Technical Characteristics (TC).

c. Review all instructional material issued with the test item by the manufacturer, contractor, or government, as well as reports of previous similar tests conducted on the same types of equipment. These documents shall be kept readily available for reference.

d. Prepare record forms for systematic entry of data to include; data forms, check lists, questionnaires (opinions shall be labeled as such, and separated from factual data), error forms and error likely forms (see Appendix A).

e. Prepare adequate safety precautions to provide safety for personnel and equipment, and ensure that all safety SOP's are observed throughout the test and that the item has successfully completed the examination prescribed in MTP 8-3-506.

f. Ensure that arrangements for supporting and participating agencies, activities, and facilities have been made, and that all test personnel have been briefed on human factors engineering (preferably by a human factors engineer), the purpose of the test, and anticipated results.

g. Prior to beginning operational testing, verify that the equipment is aligned, if necessary, as specified in the pertinent operating instructions to ensure, insofar as possible, it represents an average equipment in normal operating condition.

6.2 TEST CONDUCT

NOTE: The human factors aspects listed herein shall be concurrently evaluated during all phases of the commodity service testing, as applicable.

6.2.1 Personnel

a. Determine and record the following:

1) Name, rank, and service number of each test soldier.
2) Length of military service (to include combat experience, if any).
3) MOS.
4) Length of time and status of training in MOS held.
5) Qualification in arms.
6) Amount of HFE pretest training received and attitude toward test.

b. Measure each of the test soldiers and record their static body dimensions.

NOTE: These data will determine if the test soldiers are within the 5th through the 95th percentile. (The 5th percentile of a particular dimension is a value such that 5% of the personnel are smaller than the value expressed and 95% are larger. Conversely, the 95th percentile for a particular dimension is a value such that 95% of the personnel are smaller than the value expressed and 5% of the personnel are larger).

c. Measure and record all critical design dimensions of the item under test relative to the anthropometric data shown in Appendix B as they apply to the representative test soldiers.

6.2.2 Instructional Aspects

a. Carefully examine all instructional material issued with the item under test for clarity and adequacy of instructional matter. Record detailed comments concerning the adherence of the printed material to the following:

1) Form of Presentation

a) The form of presentation is appropriate for its purpose.
b) Step-by-step instructions are provided for all operations.
c) Drawings or photographs are used to clarify written instructions or to provide extra information where needed.

NOTE: Good quality drawings are at least as effective as photographs because photographs frequently show too much detail and thus obscure the point they are supposed to illustrate. On the other hand, photographs with irrelevant details blanked out and relevant details high-lighted can be very effective.

d) Tables are used for presenting data with instructions stating when and how each table should be used.
e) Tabular data is provided that can be used without having to make conversions or transformations.
f) Diagrams are used to describe processes and interrelationships.
g) Components are shown in data flow diagrams in the same relative position they are in the equipment, if practicable.
h) Electrical characteristics of the signal are shown in data flow diagrams; not the electrical characteristics of the component.

2) Instructional Content

a) Only the information needed to do the job is provided; excessive detail, unnecessary theory, and too many words are avoided.

b) Instructions are geared to the task, separate instructions are provided for each kind of task.
c) Symbols and names in the instructions agree with those actually used on the equipment.
d) In-tolerance signal characteristics and the acceptable tolerances for each test point are provided, where applicable.
e) Job instructions are indexed thoroughly, and the index contains the works an operator is likely to look for in locating a particular item.
f) All information in the instructions is accurate.

b. Record narrative comments throughout the entire test period concerning the ability of each test soldier to absorb training relative to assembly, disassembly, operation, and maintenance.

6.2.3 Battlefield Mobility

a. Utilizing an average trained crew, subject the item under test to air drop and battlefield operations in accordance with the procedures given in MTP's 7-3-511 and 8-3-502.

b. During the performance of Step (a) above, record detailed answers to the following questions based upon information derived from interviews, questionnaires, and daily observation:

1) Can the test soldier lift the item, mount it on his person and move about with it? (Applicable to man-portable items).
2) Is the configuration and center of balance such that two or more men can easily transport the item (e.g., smoke generators)?
3) What difficulty, if any, is encountered by the test soldiers moving over rough terrain?
4) What difficulty, if any, is encountered by the parachutist in executing a jump while carrying the equipment?
5) What difficulty, if any, is encountered by the test soldier transporting the item by applicable air and ground vehicles?

6.2.4 Operational Aspects

a. Throughout the course of all service testing performed on the item under test, monitor all operational aspects of the test item with respect to human factors engineering.

b. Record narrative comments obtained from all test personnel through daily observation, interview, and questionnaire concerning the following:

1) The ease of operation.
2) The strain or fatigue produced.
3) The effects of heat, cold, humidity, darkness, noise, etc., on soldier efficiency.
4) Factors in the design which degrade soldier performance, e.g.,

hard trigger pull, difficult starting of motor (chain or rope pull), interference with other equipment worn, difficulty in reading dials or meter, etc.

6.2.5 Maintenance

a. Throughout the conduct of all testing as outlined in this MTP, maintain a record of performance of all scheduled and unscheduled maintenance as prescribed in the appropriate draft publications.

b. Record narrative comments obtained from all test personnel through daily observation, interview and questionnaire concerning the following:

1) The ease with which test soldiers can perform with the tools assigned.
2) The ease of replacing modular parts, if any.
3) The ease of reaching areas to be serviced.
4) The ease of reading and understanding maintenance instructions.
5) Compatibility of the design of the equipment with maintenance functions.

6.2.6 Special Considerations for CB Equipment

6.2.6.1 Auxilliary Equipment

a. Arrange the test item auxilliary equipment for transportation, installation, operation, maintenance, or such other configuration as indicated by intended usage, technical design, and test requirements.

b. Record narrative comments obtained from all test personnel through daily observation, interview and questionnaire concerning the following:

1) The ease of opening containers, and transferring liquids or powders from one container to another.
2) The ease of mixing, if required.
3) The compatibility with test soldiers equipped with individual protective equipment.
4) The compatibility with test soldiers equipped with various environmental clothing.
5) The accessibility of controls, levers, connections, etc.
6) Apparent psychological effects caused by handling certain CB equipment and agents.

6.2.6.2 Collective Protection Systems

a. Arrange the test item collective protection systems for transportation, installation, operation, maintenance, or such other configuration as indicated by intended usage, technical design, and test requirements.

b. Record narrative comments obtained from all test personnel through daily observation, interview and questionnaire concerning the following:

1) The reactions of test soldiers working in a confined, pressurized area (heat, fatigue, etc.).
2) The ability of the test soldiers to enter and exit through the protective entrance while wearing protective clothing and equipment.
3) The ability of the test soldiers to see or hear warning devices indicative of system malfunction.
4) Possible physiological manifestations of the test soldiers (e.g. claustrophobia).

6.2.6.3 Decontamination Equipment

a. Arrange the test item decontamination equipment for transportation, installation, operation, maintenance, or such other configuration as indicated by intended usage, technical design, and test requirements.

b. Record narrative comments obtained from all test personnel through daily observation, interview and questionnaire concerning the following:

1) The ease of reaching and operating controls.
2) The ease of refilling and recharging test item.
3) The ease of holding apparatus while discharging decontaminant under pressure.
4) The ease of operating and transporting the item when test soldiers are equipped with CB protective clothing and mask.
5) The ease of operating and transporting the item when test soldiers are equipped with environmental clothing.
6) The effects caused by exposure to decontamination agents.

6.2.6.4 Detection and Surveillance Equipment

a. Arrange the test item detection and surveillance equipment for transportation, installation, operation, maintenance, or such other configuration as indicated by intended usage, technical design, and test requirements.

b. Record narrative comments obtained from all test personnel through daily observation, interview and questionnaire concerning the following:

1) The ease of operation to include selection and replacement of reagents, ease of calibration, and ease of tape replacement, if applicable.
2) The ability to read and interpret meters, dials, etc., including the skill level required to evaluate these readings.
3) The ability to observe and/or hear warning signals.

6.2.6.5 Dissemination Devices

a. Arrange the test item dissemination devices for transportation, installation, operation, maintenance, or such other configuration as indicated by intended usage, technical design, and test requirements.

b. Record narrative comments obtained from all test personnel through daily observation, interview and questionnaire concerning the following:

1) The ease of preparing test item for operation to include filling and charging, if applicable.
2) The ease of back packing test item, if applicable.
3) The accessibility of control knobs and levers.
4) The ease of trigger pull, if applicable (flame throwers).
5) The ease of operating and transporting the item when test soldiers are equipped with CB protective clothing and mask.
6) The ease of operating and transporting the item when test soldiers are equipped with various environmental clothing.

6.2.6.6 Munitions

a. Arrange the test item munitions for transportation, installation, operation, maintenance, or such other configuration as indicated by intended usage, technical design, and test requirements.

b. Record narrative comments obtained from all test personnel through daily observation, interview and questionnaire concerning the following:

1) The ease of employing hand and weapon launched incendiary, smoke and riot control grenades.
2) The ease of employing chemical and flame land mines.
3) The ease of employing riot control multiple submunitions systems.
4) The ease of transporting and employing the item when test soldiers are equipped with individual CB protective equipment.
5) The ease of transporting and employing the item when test soldiers are equipped with various environmental clothing.
6) The compatibility with left-handed operators.
7) The ease of handling misfires.

6.2.6.7 Individual Protective Equipment

a. Throughout the conduct of all testing as outlined in this MTP, constantly monitor the performance of all test personnel when attired in individual protective equipment.

b. Record narrative comments obtained from all test personnel through daily observation, interview and questionnaire concerning the following:

1) The ease and comfort of fitting (e.g., masks for personnel with extra large or extra small faces; pinching or constriction of clothing).
2) The ease and speed of donning and doffing the equipment.
3) Rashes or skin irritations caused by wearing protective clothing.
4) The ability to perform normal duties while wearing individual protective equipment.
5) The ease of respiration (inhalation and exhalation).
6) Visibility (with and without optical inserts).
7) Voice transmittability.
8) Compatibility with test soldiers wearing various environmental clothing.

6.3 TEST DATA

6.3.1 Preparation for Test

Data to be recorded prior to testing shall include but not be limited to:

a. Sufficient narrative comments pertaining to; training, logistical requirements, and statistical considerations to provide background information to be used in the analysis of test results.

b. Test, Control and Ancillary/Support Equipment Data:

1) Nomenclature
2) Serial Number(s)
3) Manufacturer's name
4) Function of item
5) Photographs

6.3.2 Test Conduct

Data to be recorded in addition to specific instructions listed below for each individual subtest shall include a logbook containing, in chronological order, pertinent remarks and observations such as weather, test soldier's uniforms and equipment, and time of day, which will aid in subsequent analysis of test data.

Extensive use shall be made of photographs, motion pictures and/or video tape to support test findings. Fast frame photography, when available, should be used to evaluate these human engineering aspects of the test.

6.3.2.1 Personnel

Record the following:

a. Name, rank, and service number of each test soldier
b. Length of military service (to include combat experience, if any)
c. MOS
d. Length of time and status of training in MOS held
e. Qualification in arms
f. Amount of HFE pretest training received and attitude toward test
g. Physical characteristics of test soldiers
h. Critical design dimensions of test item

6.3.2.2 Instructional Aspects

Record the following:

a. Detailed comments as delineated in paragraph 6.2.2
b. The ability of the average test soldier to absorb training
c. Aspects of the equipment which require complex training

6.3.2.3 Battlefield Mobility

Record the following:

a. The relationship of the test soldier to the physical characteristics of the test item.
b. Any difficulties encountered in man-transporting the equipment over rough terrain.
c. Any difficulties encountered by the parachutist jumping with the equipment.
d. Any difficulties encountered in transporting the equipment over rough terrain utilizing applicable air and ground vehicles.

6.3.2.4 Operational Aspects

Record the following:

a. Any factors of an HFE nature which degrades the efficiency of the operation of the equipment.
b. Test soldiers comments relative to ease of operation.

6.3.2.5 Maintenance

Record the following:

a. Any factors of an HFE nature which degrade the performance of maintenance.
b. Test soldiers and maintenance personnel comments relative to ease of performing maintenance.

6.3.2.6 Special Considerations for CB Equipment

6.3.2.6.1 Auxilliary Equipment

Record the following:

a. A description of the CB equipment tested
b. Narrative comments as delineated in paragraph 6.2.6.1

6.3.2.6.2 Collective Protection Systems

Record the following:

a. A description of the CB equipment tested
b. Narrative comments as delineated in paragraph 6.2.6.2

6.3.2.6.3 Decontamination Equipment

Record the following:

a. A description of the CB equipment tested

b. Narrative comments as delineated in paragraph 6.2.6.3

6.3.2.6.4 Detection and Surveillance Equipment

Record the following:

a. A description of the CB equipment tested
b. Narrative comments as delineated in paragraph 6.2.6.4

6.3.2.6.5 Dissemination Devices

Record the following:

a. A description of the CB equipment tested
b. Narrative comments as delineated in paragraph 6.2.6.5

6.3.2.6.6 Munitions

Record the following:

a. A description of the CB munitions tested
b. Narrative comments as delineated in paragraph 6.2.6.6

6.3.2.6.7 Individual Protective Equipment

Record the following:

a. A description of the CB equipment tested
b. Narrative comments as delineated in paragraph 6.2.6.7

6.4 DATA REDUCTION AND PRESENTATION

a. Processing of test data shall, in general, consist of organizing, marking for identification and correlation, and grouping the test data according to subtest title. Test criteria or test item specifications, where required, shall be noted on the test data presentation to facilitate analysis and comparison. Where necessary, test data measurements shall be converted to be compatible with units given by test criteria or specifications.

b. Statisticians shall be present to observe or participate in operational test to the extent necessary to become familiar with the actual data collection methods, and to advise on the validity of data being collected.

c. All data shall be reduced to a concise, meaningful form. These data will be analyzed to determine whether the test item met the established HFE criteria. In this analysis, opinion should be separated from factual data, and be identified as such. Where opinion influenced the evaluation of factual data, this shall be identified.

d. The evaluation of the HFE aspects of the service testing of the item shall be presented as a portion of the test report.

APPENDIX A

HUMAN FACTORS EVALUATION

1. SYSTEM AND TASK ANALYSIS

Before any evaluation of the human factors in a CB test item can be undertaken it is necessary to learn as much as possible about what people will have to do with the equipment in an operational situation in the field. This requires a system and task analysis for systematically defining the equipment, personnel, facilities, and procedures required to accomplish the mission. The analysis should be done to the level of detail necessary for determining the human factors objective and developing the test and evaluation techniques. For complex systems, the analysis may include the following overlapping steps:

a. Preparation of functional flow block diagram to depict the sequence and interaction of operations and control functions.

b. Analysis of each flow block to determine:

1) Detailed functions
2) Time and accuracy requirements for performance of functions
3) The consequences if these requirements are not met

c. Preparation of a description of man-equipment interactions brought about by an operator accomplishing a unit of work (showing the sequential manual and intellectual activities of the operator).

2. TEST AND EVALUATION METHODS

It is highly desirable that a human factors specialist be consulted during the preparation of test plans and the analysis of human factors aspects of the service test. However, test personnel with a limited knowledge of human factors principles can conduct a satisfactory evaluation after careful planning and preparation. Basic and well known methods of performance measurement are used. These methods might include: (1) observation and measurement, (2) check lists for general guidance, (3) interview and questionnaire, and (4) comparative tests made under controlled conditions of environmental stress and task interference.

The most direct way of evaluating problems in human engineering is to visually observe the equipment and the human operators in an actual working situation. Although the observational method is not the complete answer in all situations, it is used in some form and to some degree, alone or in combination with other methods, in every evaluation. The most commonly used methods and techniques are listed below:

a. Operator Opinions - obtained by interviews and questionnaires.

b. Activity Sampling Techniques - timing of operator activity and the steps required for completion of a work unit, e.g., activities and steps in filling, charging, and firing a flame thrower.

c. Process Analysis - a group of techniques for recording compactly

the various steps involved in a process, and employing process charts, flow diagrams and link analysis.

d. Records - records of tests previously made on the equipment; equipment failure and maintenance records.

3. CONDITIONS FOR TESTING

During the course of the commodity service test, human factors which cannot be measured quantitatively (e.g., operability), should be evaluated during those periods and under operational conditions most closely resembling conditions expected to be encountered by the system in actual use. The conditions outlined in the paragraphs which follow should be observed.

a. Require the equipment to carry out those missions, and only those missions, for which it is intended or to which it is likely to be assigned.

b. The tasks to be performed should be a fair sample of those to be performed when the equipment is in actual use, and should be comparable in speed, number, and difficulty to those with which the equipment must cope in the future. The following steps should be taken to fulfill this requirement:

1) Require operators to work at realistic speeds. Demonstrations that permit operators to work at their own pace can make a system appear to be more accurate and to work more smoothly than it will work in actual service.
2) Give operators the same amount and kind of work that they will have in future operational situations. Systems that perform well at light or moderate loads may break down when higher loads are imposed.
3) Make all aspects of the task difficulty realistic; the problems should not be too easy, nor should they be problems to which the operators already know the answers.
4) Require operators to observe all the rules of realistic operation; even if some of the rules are not directly pertinent to the evaluation, they are necessary to duplicate the effects of the task on the performance of the system.

c. Make the physical and environmental conditions duplicate those to be found in the future use of the equipment. If extreme conditions of heat, cold, humidity, cramping of the body, long and fatiguing watches, etc., are to be encountered in operational use, these should be included in the conditions of the system evaluation. These conditions should produce, for the operators, the same tasks, stresses, motivation, and knowledge of results that they will be subjected to under operating conditions.

d. Make certain that the operators used in the evaluation represent those who will be operating the equipment in actual use, particularly with respect to such characteristics as age, physical characteristics, general ability, experience, and training. The following guides will be useful in accomplishing this objective:

1) Avoid the use of biased subjects - those that may have some

stake in the outcome of the evaluation. A person who wants one system to be better than another, or expects it to be, is prejudiced. No matter how much he tries to be fair, his prejudices influence his performance and judgment.

2) Do not use "expert" equipment operator personnel as test operators. Personnel who are unusually experienced, except as required to determine non-human performance factors, often tend to prefer the familiar and distrust the new and different. They may suffer from habit interference; having developed one set of habits with conventional systems makes it more difficult for them to use a new system effectively.
3) Motivate the operators to the same extent they are likely to be motivated in the future use of the system. If they feel they are just doing "exercises" they are likely to perform considerable below par. One way of obtaining realistic motivation is to provide quick and correct knowledge of results to the operators. They should have the same kind of feedback from their activities as they would have in operational situations.
4) The following general rules for the training of operators should be observed:

    a) Give operators adequate instruction in the tasks to be performed.
    b) Provide an objective measure of training by scoring and recording their performance.
    c) Continue training until further improvement is negligible.
    d) When two systems are being compared, make certain that the personnel operating the two systems have comparable training in handling their respective tasks.

e. Both machines and men, but particularly men, are likely to vary in their performance over a period of time. To minimize the influence of this variability on the outcome of an evaluation, that is, to prevent it from unfairly biasing the results, the conditions of testing should be counterbalanced in every way that might possibly bias the results. To do so the evaluator should observe the following:

1) If possible, make a comparison of systems at exactly the same time. If this is not possible, then switch back and forth between systems in a predetermined counterbalanced order. In planning a counterbalanced order, avoid simple alteration because this might introduce a bias. Instead use an "ABBA" order, where "A" is one system and "B" is another.
2) Where possible, use the same men and the same machines

in the evaluation of different systems. This minimizes the possibility that differences in outcome can be attributed to irrelevant differences among people and equipment. If systems are simultaneously compared, or if for some reason more than one crew is required, evaluations should be repeated, switching crew "A" to system "B".

3) Some systems, of course, are different because they are made up of different equipments that impose different tasks on operators. In this case, beware of habit interference which might be involved whenever two equipments or tasks require different habits or skills. If habit interference might be a factor, then it is better not to switch operators. Instead, operators of comparable skill in their respective tasks should be selected and kept on their respective equipments.

4. DATA COLLECTION

The timely and accurate recording of test data is enhanced by:

a. Detailed data forms prepared in advance of the test and tailored to each specific subtest.

b. Check lists as convenient reminders and aids for checking equipment design features against criteria.

c. Carefully prepared questionnaires for obtaining operator opinion.

d. Human Error Report Forms (Figure A-1) for recording and analyzing operating errors as they occur.

e. Error Likely Report Forms (Figure A-2) for reporting of operating or equipment conditions which appear to operators as likely to cause errors.

HUMAN ERROR REPORT FORM

Name of Test _____

1. Name of task or subtest (if any) _____

   Title or identifying number of written procedures _____

   Page and paragraph number(s) in written procedures _____

2. Tell exactly what equipment was involved. Be complete and specific, that is, give component (or part) and the tools or test equipment involved. (Use extra sheet of paper if needed for this or other items below).

3. Tell exactly what the person making the error was supposed to do or what the task required.

4. What did he do, or fail to do, which was in error? Describe the error.

(Note: As a check on how well you have completed the above 4 items, given your description of the error, could someone else familiar with the equipment deliberately make the error you have described?)

5. Did time-pressure, weather, hazards, or other test conditions contribute to the error? How?

6. What had to be done (or what should have been done) to correct the error?

7. What were the consequences of the error?

8. What do you think would be the likely consequences of this error in the operational situation?

9. Do you think this error whould be less, about the same, or more likely in the operational situation? Why?

10. What suggestions do you have to correct the above situation? Your suggestions might involve changing the equipment, the procedures, the MOS, or the training given beyond the MOS.

Name and Rank _____

Date _____

Figure A-1 HUMAN ERROR REPORT FORM

ERROR LIKELY REPORT FORM

Name of Test _____

1. Name of task or subtest (if any) _____

   Title or identifying number of written procedures _____

   Page and paragraph number(s) in written procedures _____

2. Tell exactly what equipment is involved. Be complete and specific, that is, give component (or part) and the tools or test equipment involved. (Use extra sheet of paper if needed for this or other items below).

3. Tell exactly what the person is expected to do or what the task requires.

4. Tell why this is an error likely situation. That is, tell exactly where or how an error is likely to be made. Try to keep in mind the potential operational situations, that is, the weather, possible enemy action, time-pressures, hazards, and so on. (If you have seen anyone almost make this error, tell what he did).

5. Could the error be corrected if made. If so, how?

6. What would be the likely consequences of the error in the operational situations?

   (Note: As a check on how well you have completed the above 6 items given of your description of the error, could someone else familiar with the equipment deliberately make the possible error you have described?)

7. What suggestions do you have to correct the above situation? Your suggestions might involve changing the equipment, the procedures, the MOS, or the training given beyond the MOS.

Name and Rank _____

Date _____

Figure A-2 ERROR LIKELY REPORT FORM

APPENDIX B

ANTHROPOMETRIC DATA

Table I. Standing Body Dimensions

KEY TO FIG. 1	DIMENSION	5TH PERCENTILE	MEAN	95TH PERCENTILE
A	Vertical Reach	77.0	83.6	90.3
B	Stature	65.2	69.1	73.1
C	Eye Height	60.8	64.7	68.6
D	Shoulder Height	52.8	56.5	60.2
E	Elbow Height	40.6	43.5	46.4
F	Wrist Height	31.0	33.5	36.1
G	Knuckle Height	27.7	30.0	32.4
H	Kneecap Height	18.4	20.2	21.9
I	Ankle Height	4.9	5.6	6.8
J	Chest Depth	8.0	9.1	10.4
K	Buttock Depth	7.6	8.8	10.2
L	Functional Reach	29.7	32.3	35.0
M	Depth of Reach	23.0	--	--

Table II. Seated Body Dimensions

KEY TO FIG. 2	DIMENSION	5TH PERCENTILE	MEAN	95TH PERCENTILE
N	Seated Height	33.8	35.9	38.0
O	Eye Height	29.4	31.5	33.5
P	Shoulder Height	21.3	23.3	25.1
Q	Elbow-Rest Height	7.4	9.1	10.8
R	Thigh-Clearance Height	4.8	5.6	6.5
S	Knee Height	20.1	21.7	23.3
T	Buttock-Knee Length	21.9	23.6	25.4
U	Popliteal Height	15.7	17.0	18.3
V	Forearm-Hand Length	17.6	18.9	20.2
W	Buttock-Leg Length	39.4	42.7	46.1
X	Buttocks-to-Inside-Knee	17.7	18.9	20.2
Y	Elbow-to-Elbow Breadth	15.2	17.3	19.8
Z	Hip Breadth	12.7	14.0	15.4
AA	Shoulder Breadth	16.5	17.9	19.4
BB	Span	65.9	70.8	75.6

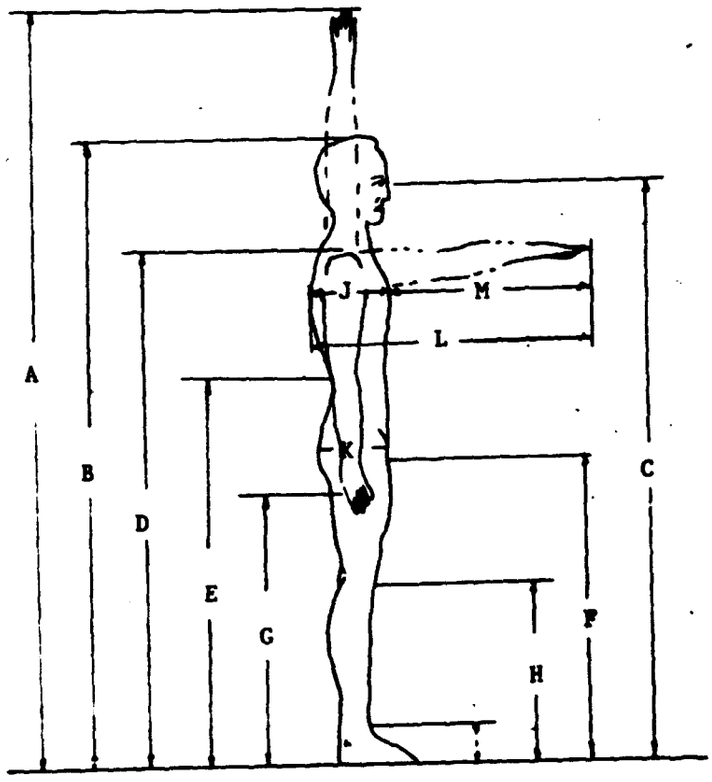


Figure 1. Standing Body Dimensions.

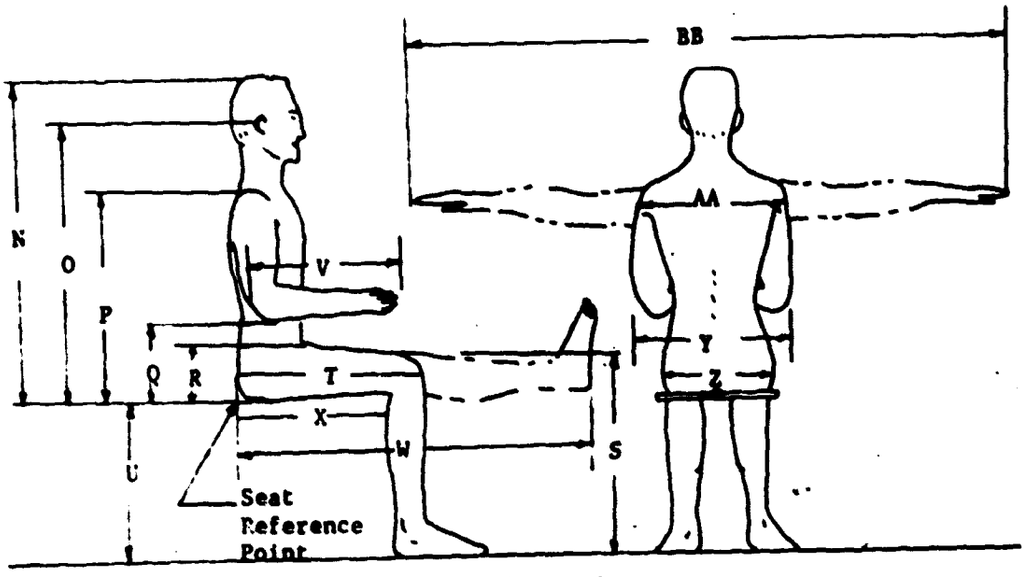
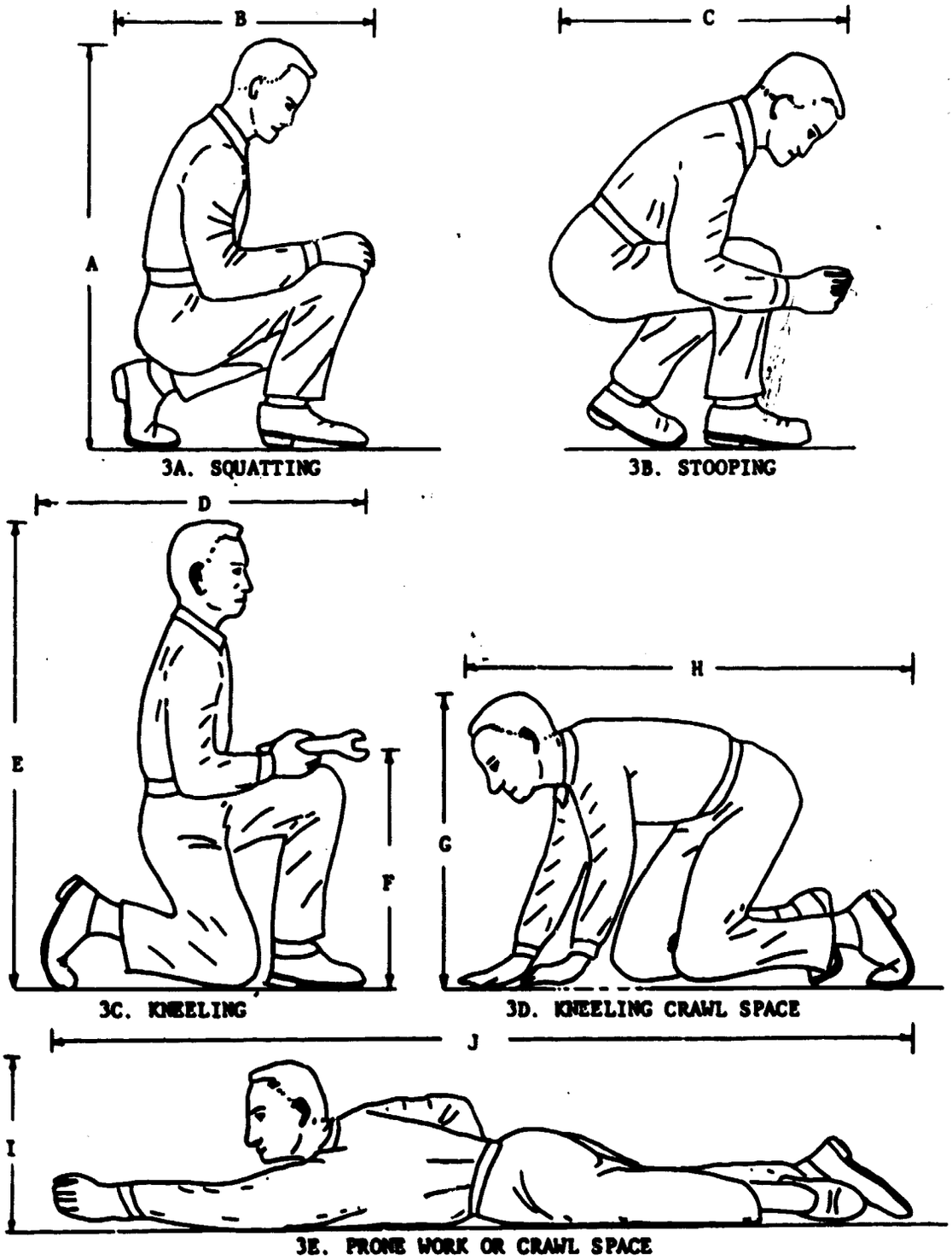


Figure 2. Seated Body Dimensions.



3A. SQUATTING

3B. STOOPING

3C. KNEELING

3D. KNEELING CRAWL SPACE

3E. PRONE WORK OR CRAWL SPACE

Figure 3. Clearance Dimensions

Table III. Clearance Dimensions

KEY TO FIG. 3	DIMENSION	MINIMUM	PREFERRED	ARCTIC CLOTHING
3A.	Squatting workspace:			
A.	Height:	48	--	51
B.	Width:	27	36	40
3B.	Stooping workspace:			
C.	Width:	36	40	44
3C.	Kneeling workspace:			
D.	Width:	42	48	50
E.	Height:	56	--	59
F.	Optimum work point:	--	27	--
3D.	Kneeling crawlspace:			
G.	Height:	31	36	38
H.	Length:	59	--	62
3E.	Prone work or crawlspace:			
I.	Height:	17	20	24
J.	Length:	96	--	--

APPENDIX C

CATEGORIES OF CB EQUIPMENT

1. AUXILIARY EQUIPMENT

These are items which are used in shipment, filling, field impregnation of clothing, and similar operations. They are generally used in conjunction with other items.

2. COLLECTIVE PROTECTION SYSTEMS

These systems are designed to provide and maintain filtered air under positive pressure at a level which precludes the infiltration of hazardous levels of toxic agents. These systems are adaptable for use with field medical facilities, and other shelters such as command posts, communications centers, portable pressurized shelters, and certain vehicles and vans. Included in this category are:

a. Collective Protection Systems, Vehicles and Vans
b. Collective Protection Systems, Field Shelters
c. Collective Protection Systems, Fixed Installations

3. DECONTAMINATION EQUIPMENT

These items of equipment are designed to facilitate the process of making any person, object, or area safe by absorbing, destroying, neutralizing, making harmless, or removing chemical or biological agents. Included in this category are:

a. Decontaminating Apparatus, Portable
b. Decontaminating Apparatus, Power Driven, Vehicular or Skid-Mounted
c. Decontamination Kit, Individual, Field

4. DETECTION AND SURVEILLANCE EQUIPMENT

This equipment is intended to provide friendly troops with sufficient notice of a CB agent attack to enable them to take adequate protective measures. Included in this category are items with the capability of sampling and identifying chemical agents, detection of personnel, or marking, tracking and identification of personnel. This classification of equipment includes:

a. Alarms, Biological
b. Alarms, Chemical
c Chemical Agent Detector Kit
d. Sampling and Analyzing Kit
e. Personnel Detector
f. Marking, Tracking, and Identification System
g. Field Laboratories

5. DISSEMINATION DEVICES

This equipment is intended for use in distributing relatively large quantities of CB agents, smoke, or flame over a large area. These items include the following:

a. Disperser, Riot Control Agent, Portable
b. Disperser, Riot Control Agent, Vehicular or Helicopter-Mounted
c. Generator/Dispenser Devices, Field, Biological
d. Screening Smoke Dissemination Sub-System for Army Aircraft
e. Tanks, Spray, Antipersonnel, Anticrop and Defoliant Agent.
f. Generators, Smoke, Mechanical
g. Flame Throwers
h. Encapsulated Flame Weapons

6. MUNITIONS

These items of equipment are designed for the delivery of CB agents, smoke, or incendiaries to selected targets, and include:

a. Bomblets, Biological.
b. Bomblets, Chemical.
c. DIACBA Munitions.
d. Target and Area Smoke Marking Munition Sub-System for Army Aircraft.
e. Generators, Smoke, Pot.
f. Grenades, Hand, or Weapon Launched, Smoke/Incendiary.
g. Grenades, Hand, or Weapon Launched, Smoke, Colored Marking.
h. Grenades, Hand, Riot Control.
i. Mines, Land, Chemical or Flame.
j. Multiple Sub-Munitions Systems, Riot Control.
k. Projectile and Cartridges, Chemical, Biological, Smoke/Incendiary.
l. Warheads, Guided Missile, Biological Agent.
m. Warheads, Guided Missile, Chemical Agent.
n. Warheads, Rocket, Chemical Agent.

7. INDIVIDUAL PROTECTIVE EQUIPMENT

These items of equipment are designed to protect the individual from the effects of CB agents by (1) preventing the entry of such agents into the respiratory system, or (2) decreasing the cutaneous and percutaneous hazards. Included in this category are:

a. Boots, Protective
b. Breathing Apparatus, Self-contained Air/Oxygen Supply
c. Ensemble, Protective, Supplied Air
d. Gloves, Protective
e. Hoods, Protective
f. Liners, Protective
g. Masks, Protective
h. Overgarment, Protective, Disposable
i. Respirators
j. Casualty Bags

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13. ABSTRACT
This Army Service Test Procedure describes test methods and techniques for evaluating the Human Factors Engineering aspects of Chemical-Biological equipment and its compatibility with the skills, aptitudes and limitations of military personnel who will use the items.

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