AD NUMBER

AD871349

NEW LIMITATION CHANGE

TO

Approved for public release, distribution unlimited

FROM

Distribution authorized to U.S. Gov't. agencies and their contractors; Critical technology; 23 Mar 1970. Other requests shall be referred to US Army Test and Evaluation Command, Attn: AMSTC-TS, Aberdeen Proving Ground, MD, 21005.

AUTHORITY

USATEC ltr, 14 Dec 1970

(20)

23 March 1970

Materiel Test Procedure 10-2-192
General Equipment Test Activity

U. S. ARMY TEST AND EVALUATION COMMAND
COMMODITY ENGINEERING TEST PROCEDURE

DIVING EQUIPMENT (HELMETS, BELTS, DIVERS DRESS, ETC.)

1. OBJECTIVE*

This document provides test methods and techniques necessary to determine the technical performance and safety characteristics of diving equipment, as described in Qualitative Materiel Requirements (QMR's), Small Development Requirements (SDR's), Technical Characteristics (TC's), and to determine the test item's suitability for service tests.

2. BACKGROUND

Requirements exist for diving equipment for use during underwater work assignments such as ship salvage, search and recovery, inspection and repairs, construction, and tactical offense and defense.

Diving equipment is classified in the following three categories: surface-supplied diving equipment; self-contained diving equipment, including self-contained underwater breathing apparatus (SCUBA); and diving accessories.

Surface-supplied equipment types are all supplied with air or some other suitable breathing media through hoses from the surface, and are used where stability is more important than great mobility. Currently, there are three equipment types in this category: the deep sea diving outfit, consisting of helmet, watertight dress, weighted belt and shoes, supply hose and control valve, non-return valve, exhaust valve, spitcock, helmet cushion, woolen socks, woolen underwear, breastplate, communications reproducer, rubber cuffs or divers-tenders gloves, wrist straps, overalls, knife, and airhose; the lightweight diving outfit, comprised of a rifle cartridge belt with lead weights, leather weighted belt, lightweight rubberized diving dress, hose, mask with inlet and exhaust valves, control valve, non-return valve, and other items identical to those of the deep sea diving outfit (cuffs, gloves, knife, overalls, shoes, and underwear); and the helium-oxygen diving outfit, similar to the deep sea diving outfit, with modification of the standard diving helmet to incorporate a helium-oxygen recirculation device and goosenecks for the carbon dioxide absorbent canister and the electrically heated underwear cabling, and the addition of a secondary exhaust check valve, a Hoke valve, an absorbent canister, and electrically heated underwear.

Self-contained equipment types are those in which the diver carries his own breathing media and can thus be independent of surface connections. Three types of SCUBA are presently in use: the demand type (open-circuit SCUBA), made up generally of compressed air cylinders, air reserve mechanism, check valves, demand regulator, breathing tubes, mask and/or mouthpiece, and exhaust

*This MTP is intended to be used as a basic guide in preparing actual test plans for the subject equipment. Specific criteria and test procedures must be determined only after careful appraisal to pertinent QMR's, SDR's, TC's, and any other applicable documents.

31

valve; the closed-circuit SCUBA, comprised of oxygen cylinders (never air or mixed gas), oxygen control valve, rebreathing bag, breathing tube(s), check valves, mask or mouthpiece, canister, and relief valve; the semi-closed SCUBA, consisting of nitrogen-oxygen cylinders, manifold, regulator, filter, metering orifice, bypass valve, breathing bag, check valves, breathing tubes, full face-mask and/or mouthpiece, absorbent canister, exhaust valve, harness, and weights.

Diving accessories include equipment items for use on board the diver tender to supply the diver with breathing media, communications, electricity for heat and light, means of entering and leaving the water and of accomplishing decompression, helmet and outfit storage chests, tools, spares, and floats. Other accessories are those used by the diver to perform his work, such as toolbags, welding faceplates and welding lenses, gym shoes, descending and distance lines, lights, surface and float lines, slates, flashlights, and swim fins. Still other accessories are used primarily or entirely to protect the diver's personal safety; some of these are stopwatches, life preservers, signal flares, wrist compasses, wristwatches, and depth gages. Finally, there are those accessories which are required by the diver to the degree that they might be considered integral parts of his basic diving equipment. The surface-supplied diver uses high-pressure hose and couplings, combination amplifier and life line cable, and cable to supply electricity for the heated underwear. The SCUBA diver uses the standard divers knife or the standard combat sheath knife and belt, a weighted belt, an exposure suit, and special valves, such as drain, cutoff, and surface breather valves.

3. REQUIRED EQUIPMENT

a. Scales.
b. Measuring Tape.
c. Analytical Balance, accuracy ± 0.01 gram.
d. Direct Reading Balance, accuracy ± 0.05 ounce.
e. Glass-Stoppered Erlenmeyer Flask.
f. Colorimetric pH Comparator with standard tubes.
g. Color Comparison Standards.
h. Bursting Strength Tester, ball burst assembly.
i. Bourdon Tube, maximum-reading type pressure gage, accuracy ± 1% of maximum capacity.
j. Thermometer.
k. Air Hose.
l. Pressure Gage.
m. 12 inch Pulley.
n. Weights.
o. Six-ounce Weight Tension Clamp.
p. Straining Mechanism and Specimen Holding Clamps.
q. Load and Elongation Autographic Recording Mechanism.
r. Shore A Durometer.
s. Water tank.
t. Circulating Air Oven, thermostatically controlled, accuracy ± 2°C.
u. Surface Support During Test Equipment.
v. Magnetic Testing Facility.
w. Air Compressor and Pump with regulated and filtered output.

x. Vibration Testing Facility.
y. Drop Testing Facility.
z. Equipment and facilities as required in referenced MTP's.

4. REFERENCES

A. USATECOM Regulation 385-6, Verification of Safety of Materiel During Testing.
B. USATECOM Regulation 700-1, Value Engineering.
C. USATECOM Regulation 705-4, Equipment Performance Report.
D. AMCP 706-134, Maintainabilty Guide for Design.
E. FED-STD 601, Rubber, Sampling and Testing.
F. FED-STD-101a, Preservation, Packaging, and Packing Materials, Test Procedure.
G. FED-STD-151, Metals, Test Methods.
H. FED-STD-191, Textile Test Methods.
I. MIL-P-116E, Preservation, Methods of.
J. MIL-STD-129, Marking for Shipment and Storage.
K. MIL-STD-130C, Identification Marking of U. S. Military Property.
L. MIL-M-19595, Magnetic Effects Limits for Nonmagnetic Equipment and Metals (Special Purpose).
M. NAVSHIPS 250-538, U. S. Navy Diving Manual.
N. NAVSHIPS DWG. S9400-921597, Divers Cuffs and Expanders and Elastic Tubing and Cuff Straps.
O. NAVSHIPS DWG. S9400-921883, Standard Plan, Diver's Dress, Assemblies, and Details.
P. NAVSHIPS DWG. S9400-921884, Standard Plan, Diver's Dress, Details.
Q. NAVSHIPS DWG. S9400-921590, Diver's Helmet.
R. Official Classification Committee, Uniform Freight Classification Rules.
S. MTP 10-2-213, Diving Equipment SCUBA.
T. MTP 10-2-500, Physical Characteristics.
U. MTP 10-2-501, Operator Training and Familiarization.
V. MTP 10-2-503, Surface Transportability, (General Supplies and Equipment).
W. MTP 10-2-505, Human Factors Evaluation.
X. MTP 10-2-507, Maintenance Evaluation.
Y. MTP 10-2-511, Quality Assurance.

5. SCOPE

5.1 SUMMARY

These procedures describe the preparation for, and the methods of, evaluating the technical performance characteristics of diving equipment.

a. Preparation for Test - A determination of the condition of the test item on arrival, a determination of the test item's physical characteristics, and the operator training and familiarization procedures.

b. Safety - A determination of the safety characteristics of the test item.

c. Maintenance - An evaluation to determine and appraise the test item's maintenance characteristics and requirements, a verification and appraisal of its malfunctions, and evaluation of the test item's associated publications

and other common and special support elements (maintenance test package), an appraisal of the test item's design for maintainability (AMCP 706-134: accessibility, ease of maintenance, standardization, and interchangeability), an evaluation of component and system durability and reliability, and the calculation of indicators which express the effects of appropriate preceding aspects.

d. Hydrostatic Tests - A determination of the test item's capability to withstand specified hydrostatic pressures.

e. Sizing and Fitting - A determination of the sizing and fitting characteristics of the test item as related to wear with standard task-oriented clothing and equipment.

f. Donning and Doffing - An evaluation of the design of the test item for the ease and safety of putting on, and removing from, the body in conjunction with standard task-oriented clothing and equipment.

g. Performance Tests - A determination of the suitability and performance of diving dress, helmets, facemasks, valves (control, non-return, exhaust, secondary exhaust check, inlet check, relief, drain, cutoff, surface breather, and bypass), gas cylinders, air reserve mechanisms, demand regulators, low pressure warning devices, and supplementary equipment.

h. Transportability - A determination of the capability of the test item to withstand the shock and vibration encountered during normal handling and transport operations.

i. Stress Tests - A determination of the test item's resistivity to external and/or internal pressure and to forces that could cause separation, bursting, tearing, or elongating.

j. Accelerated Aging Tests - A determination of the test item's estimated ability to meet the specified functional life expectancy requirements.

k. Magnetic Effects Test - A study to determine the magnetic effect and suitability of the test item for use in water which may contain magnetic influence ordnance.

l. Human Factors Evaluation - A determination of the adequacy of the design of the test item and the identification of any operability and accessibility design deficiencies.

m. Value Analysis - A determination of the test item's unnecessary, costly, or nice-to-have features, as stated in USATECOM Regulation 700-1.

n. Quality Assurance - A study to determine the quality of the test item.

5.2 LIMITATIONS

This MTP is concerned only with that equipment worn or utilized by diver that enables him to live and function in an underwater environment. The testing procedures for other equipment, such as air compressors, diving amplifier, hand tools, flashlights, and watches, are not included in this MTP.

The parameters specified in these procedures shall be valid unless other parameters are specified in the test item's QMR, SDR, or TC.

6. PROCEDURES

NOTE: 1) Since the prime consideration in the selection of diving equipment for Army utilization is the safety of the diver,

all testing procedures must place great emphasis on the testing of all materials and assemblies regarding their physical characteristics and resistivity to stresses. The specific item under test shall be thoroughly evaluated to determine its effect on the diver's safety.

2) Diving equipment setup and operation, the operating techniques provided in the draft technical manuals shall be followed. Any change or deviation from these instructions shall be recorded in the test item logbook.

6.1 PREPARATION FOR TEST

6.1.1 Pre-Test Inspection

On receipt of the test item package(s), the test item shall be subjected to the following procedures:

a. Visually inspect the test item packaging and record:

1) Evidence of damage or deterioration.
2) Identification marking, if accordance with MIL-STD-129 and any special marking specified, including:

a) Manufacturer
b) Number and date of contract
c) Date of manufacture
d) Type of diving equipment

b. Weight and measure the test item package(s), and record the following:

1) For each shipping package:

a) Contents
b) Weight
c) Length, width, and height
d) Cubage

2) For entire test package (if more than one shipping package):

a) Total weight
b) Total cubage

c. Unpack the test item, and record the type and adequacy of packing material in the shipping container.

d. Visually inspect the test item, and record the following:

1) Any evidence of defects in:

a) Manufacturing
b) Material

c) Workmanship

2) Evidence of damage and/or wear.
3) Existence of shortages in test package.
4) Deviations in markings from MIL-STD-130.
5) Discrepancies in the physical condition of helmets, including the following:

a) Threads for connecting to breastplates
b) Watertight telephone connnections
c) Faceplate hinge
d) Safety lock

6) Evidence of rust and verdigris on metal surfaces.
7) Evidence of dryness, hardness or cracking in leather articles or leather parts.
8) For rubber or rubberized components; evidence of:

a) Oil and grease
b) Permanent set, cracks, and/or breaks at folds

9) Roughness, irregularity or other defects on surfaces, seams or edges of test item components.

e. Record the presence of instruction plates, if applicable, including:

1) Identification: Name and serial number
2) Pressure rating of cylinders
3) Caution instructions
4) Service and handling instructions

6.1.2 Physical Characteristics

Determine and record the physical characteristics, as applicable, of each test item, in accordance with MTP 10-2-500, and the following physical specifications of:

a. Cotton and/or woolen fabric, as per FED-STD-191:

1) Weight, as per method 5041
2) Wales and courses per inch, as per method 5070
3) pH, as per method 2810

b. Weight of coated fabric, as per FED-STD-191, method 5041.

6.1.3 Operator Training and Familiarization

a. Orient test personnel using the criteria of MTP 10-2-501 and additional test item aspects.

1) Transportability
2) Human Factors
3) Value Analysis

b. Record all pertinent data.

6.1.4 Preparation

a. Prepare the test item in accordance with the manufacturer's instructions or the draft technical manual.

b. Remove all protective material and preservatives.

c. Clean all oxygen systems in accordance with NAVSHIPS 250-538, Paragraph 1.10.11.

6.2 TEST CONDUCT

NOTE:
1. All equipment failures shall be reported in accordance with USATECOM Regulation 705-4.
2. A number of measures must be taken to ensure that the air or gas supplied to the diver and used in testing the diving equipment is of adequate purity and is within reasonable limits of pressure variation. To accomplish this, the compressor intake should be located approximately 15 feet from the engine in such a manner that the engine exhaust fumes will not be drawn into the compressor intake. The compressed breathing air should be exhausted into a volume tank, where, as a result of expansion, it will be cooled and some of the oil and moisture will be eliminated. The air should then be passed through an oil filter to remove lubricating oil and vapor. It is essential that the oil filter be kept in first-class condition to prevent the breathing air from becoming contaminated with oil and becoming noxious to the diver. Additionally, any oil in the air would accelerate deterioration of the air hose and other components of the diving equipment.
3. Testing personnel shall comply at all times with the safety regulations governing the operation of all test items and test equipment, including the use and handling of compressed gas cylinders and gases.
4. Test personnel shall be familiar with, and adhere to, the NAVSHIPS 250-538 instructions for planning, operation, safety, handling, and maintenance of diving equipment, particularly paragraphs 1.7.7 and 1.10.1.
5. Diving equipment not in use shall be cleaned and stored in chests, and stowed in a dry, cool place.
6. The test engineer shall specify those tests which are applicable to the particular item under test.

6.2.1 Safety

Testing personnel shall comply at all times with USATECOM Regulation 385-6

as well as the safety regulations governing the operation of all test items and test equipment, including the use and handling of compressed gas cylinders and gases, in accordance with NAVSHIPS 250-538, paragraph 1.77, and the particularly important rules concerning contact between oil and oxygen, paragraph 1.10.1. In addition, testing personnel shall note and record the following:

a. Adequacy of the design capabilities of SCUBA divers' weights and cylinder harnesses for quick release in case of emergency.
b. Dangerous or unsafe conditions resulting from inadequate features.
c. Dangerous or unsafe features on test item.
d. Safety features of the test item.
e. Suggestions to improve existing safety precautions.

6.2.2 Maintenance

Evaluate the maintenance-related factors of the test item as described in MTP 10-2-507, with emphasis on the following:

a. Organizational (O), Direct Support (F), and General Support (H), Maintenance requirements.
b. Operator through General Support Maintenance Literature.
c. Repair parts.
d. Tools.
e. Test and handling equipment.
f. Calibration and maintenance facilities.
g. Personnel skill requirements.
h. Maintainability.
i. Reliability.
j. Availability.

6.2.3 Hydrostatic Tests

6.2.3.1 Diver's Dress Leakage

Inflate the diver's dress with air to an internal pressure of one (1) psig for five (5) minutes to determine watertightness. Submerge the diver's dress in the water tank. Note and record any bubbling as evidence of leakage.

6.2.3.2 Permanent Expansion of Cylinders and Manifolds

a. Measure and record the volume of the test item before pressurizing.
b. Subject each cylinder and manifold to the specified hydrostatic pressure.
c. Record any evidence of leakage.
d. Keep each test item pressurized for ten (10) minutes.
e. Depressurize test item to the specified safe minimum level, and let it stand for ten (10) minutes.
f. Measure and record the volume of the test item.

6.2.3.3 Hydrostatic Pressure Resistance of Coated Fabric Seams

Determine and record the resistance of coated fabric seams of divers

dress to hydrostatic pressure in accordance with FED-STD-601, method 10511 as follows:

a. Place the coated side of the fabric next to the water, with the edge of the seam that will be exposed to the water in service contacting the water. Hold the other seam edge in such a manner that the water may penetrate the seam.

b. The water temperature shall be the same as that of the ambient atmosphere, and the water level shall be brought up flush with the surface of the circular opening in the testing machine so that no air pockets exist between the surface of the water and the surface of the coated fabric.

c. The pressure shall be applied by forcing water into the pressure chamber at a uniform rate of 50±5 ml. per minute until the hydrostatic pressure of 50 centimeters has been reached. The seams shall withstand this pressure within ± 2 pounds per square inch for 5 minutes ± 5 seconds.

6.2.4 Sizing and Fitting

Determine proper fitting of sized items of diving equipment (i.e. diving dress, underwear, woolen gloves, socks, gymnasium shoes, electrically-heated underwear, swimfins, and exposure suits) and of those unsized item which are worn (i.e. helmets, divers-tenders gloves, overalls, rifle cartridge belts, weighted leather belts, SCUBA harnesses, and facemasks) as follows:

NOTE: Sizing and fitting considerations are of particular importance, since diving equipment must fit a wide variety of body and head sizes properly and must permit the wearers maximum freedom of movement.

a. Select test subjects representative of the 5th, 50th, and 95th percentile personnel (body size and weight).

b. Issue a test item to each man. If the test item is sized, issue it in accordance with the imprinted or labeled sizing.

c. Each man shall don or emplace, in proper sequence, the test item and the clothing and equipment required for the specified mission.

d. Each man shall vary all available adjustments of the test item, if applicable, to obtain the best possible fit.

e. Each man shall perform required simulated operational and mission-oriented tasks.

f. Record the following for each test item:

1) Test item fit.
2) Obviousness of preparation required, or adequacy of preparation instructions.
3) Ease of performing required adjustments.
4) Compatibility with other equipment.
5) Non-interference with the performance of required tasks.

6.2.5 Donning and Doffing

a. Select personnel and issue test items as described in paragraph

6.2.4, steps a and b.

b. Have test subjects don and/or doff test items and test personnel record any apparent difficulties observed during donning and/or doffing.

c. Interview test subjects individually to determine and record their subjective opinions regarding the ease and safety of donning and doffing the test item with respect to the following, if applicable:

1) Suitability of fastening and adjustments
2) Ability to effect fastenings and adjustments
3) Ease of donning and doffing over clothing and other equipment
4) Apparent difficulties observed by the recorder

6.2.6 Performance Tests

6.2.6.1 Components Performance Tests

6.2.6.1.1 Safety Air Nonreturn Valve Test - Perform the following:

a. Screw the valve in a reverse manner to the end of a length of airhose, attach the hose to the air supply, and apply pressure.

b. Test the valve for positive closure at low-pressure differential increments of one-half psig from zero to three psig.

c. Immerse the valve in water at each pressure setting, and note and record any bubbling as evidence of leakage.

d. Remove the valve from the airhose, and connect it to an airtight container. Connect the airhose in a forard manner to the valve, and apply one psig air pressure.

e. Remove the air hose from the valve, observe that it has seated smartly, and record the pressure of the container. Note and record any evidence of leakage.

6.2.6.1.2 Helmet Air-Regulating Escape Valve (Exhaust Valve) Test - Perform the following:

a. Connect the valve to the end of a length of airhose in such a manner that the chin button can be depressed by the test operator at any time.

b. Open the adjusting hand wheel fully, and apply air pressure to the valve. Record the pressure at which the valve opens. (This pressure should be approximately one-half psig).

c. Close the adjusting hand wheel completely, and increase the air pressure to one psig.

d. Depress the chin button and observe the opening of the valve. Record any valve malfunction.

e. Release the chin button, and increase the air pressure. Record the pressure at which the valve opens. (This pressure should be two (2) psig).

6.2.6.1.3 Air Hose for Diving Helmets - Perform the following:

a. Cap off one end of the air hose, and connect the other end to a regulated-output air compressor.

b. Apply an instantaneous pressure of 2000 psig to burst test the

hose. Record any hose damage.

c. Apply a pressure of 1000 psig for 30 seconds to proof test the hose. Record any hose damage.

6.2.6.1.4 Absorbent Canister - Perform the following:

NOTE: Absorbents require careful handling and adequate facilities for storage. Always use fresh absorbent, not bulk absorbent that has been exposed to air for a long period of time. Fill canisters with absorbent immediately prior to use, and renew absorbent after each dive or at any time it becomes wet. Provide a way to remove dust when filling canisters, and fill carefully without excessive shaking of the canister. Avoid breathing the absorbent and permitting it to contact the skin. After use of the canister, remove all absorbent, wash out the canister thoroughly with fresh water, and dry completely. Any absorbent left in the canister will produce heavy corrosion during storage.

a. Fill the canister with absorbent, and record any difficulty encountered. Inadequate filling will result in absorbent settling during use; this could create a CO_2 bypass channel along the canister wall.

b. Observe and record the adequacy of the canister inlet and outlet screens; these should keep the absorbent compacted to prevent channeling of gases and excess shaking resulting in dust.

c. Assemble the diving apparatus according to the method prescribed by the manufacturer, making sure all connections are tight, and perform the following:

1) Connect the apparatus to the appropriate gas supply, apply the gas, submerge the apparatus in water, and observe and record continuous bubbling as evidence of leakage.
2) Have a test subject don the apparatus, perform the prescribed pre-dive routine, and breathe the appropriate gas for the amount of time corresponding to that for which the absorbent has been specified to adequately filter the gas. Have the test subject perform movement and activities to simulate those that will be performed in using the apparatus. During this test, sample the diver's breathing medium at regular intervals, measure the amount of impurities contained, and note the effectiveness of the canister and absorbent.
3) After completion of this test, remove the canister and examine the contents for any evidence of channeling or wettage. Question the test subject regarding any excessive breathing resistance encountered and record the comments and determine if adverse conditions encountered are due to the following canister design deficiencies:

a) Too small: absorbent would be rapidly exhausted.
b) Improper shape: CO_2 could be blown through, and path would soon be exhuasted; not all of the absorbent would be used.

c) Under-baffled: channeling would permit CO_2 to bypass absorbent.
d) Over-baffled: excessive breathing resistance would result; there might possibly be "dead" areas behind baffles, resulting in early exhaustion of path.
e) Inadequate prevention of water leakage: would result in absorbent becoming inactivated by water and in CO_2 passing through inactive absorbent.

6.2.6.1.5 Air Hose for Lightweight Diving Outfit -

a. Connect air hose as in paragraph 6.2.6.1.3, step a.
b. Apply 700 psig pressure for 2 minutes to burst test the hose. Record any hose damage.

6.2.6.1.6 Valves (Miscellaneous) -

Subject all other valves (control, spitcock, check, secondary exhaust, Hoke, relief, and bypass) to applicable procedures to evaluate the performance of each as standard needle valves, globe valves, or quick-acting valves, and record deficiencies.

6.2.6.1.7 Low Pressure Warning Device Operation -

NOTE: MTP 10-2-213 contains a more comprehensive test.

Determine the operability of the SCUBA low pressure warning device as follows:

a. Subject the manifold to 400 psig air pressure. The flow shall be satisfactory for swimming at pressure when the cylinder pressure is above 350 psig.
b. Lower the air pressure slowly. Record the pressure at which the warning device stops the air flow. (Minor leakage at 300 psig is permissable and may occur.)

6.2.6.2 Systems Performance Tests

NOTE: See MTP 10-2-213 for comprehensive SCUBA testing.

Only thoroughly qualified and experienced personnel should perform as divers, divers' tenders, and diving officers, even when the diving equipment is going to be tested at or near the surface of the water. This requirement is imperative in the testing and evaluation of new and/or experimental equipment. Except as otherwise specified testing personnel shall follow the customary procedures in the pre-dive, dive, and post-dive operations.

6.2.6.2.1 All Diving Equipment - Perform the following:

a. Have a test subject don the diving apparatus using procedures and methods prescribed by the manufacturer.

b. Place all applicable surface-support facilities into operation with diver-tender and other support personnel at their respective stations.

c. Operate the test item in an actual or simulated diving environment at depth and temperature extremes prescribed in the applicable QMR, SDR or TC.

d. Record the following for each dive:

1) Actual or simulated depth of dive
2) Temperature or water at dive depth
3) Duration of dive
4) Difficulties encountered and action taken
5) Evidence of leakage
6) Test subjects comments as regards:
   a) Safety
   b) Functional performance

6.2.6.2.2 Demand-type SCUBA Equipment - Perform the following:

a. Using the arrangement shown on Figure 1 and swimming against a 12-pound pull, it shall be possible for the diver to obtain sufficient air for breathing at any depth to 200 feet without excessive breathing resistance.

b. The diver shall swim for a period of 30 minutes. During the swimming test, the pressure on the high pressure side will be varied from 3000 psig down to 300 psig.

c. Record test subjects comments regarding suitability of diving equipment and record any difficulties encountered.

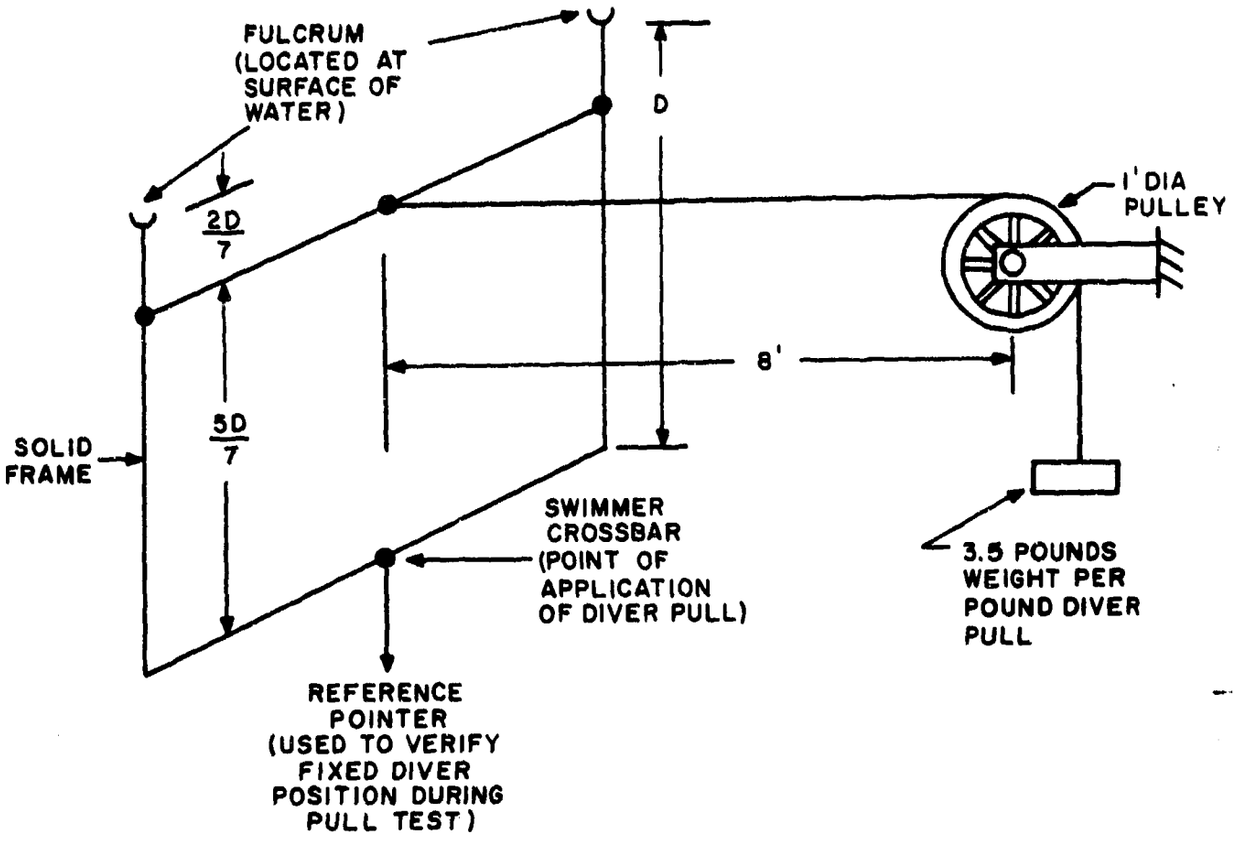
6.2.7 Transportability

Prepare the test item for transport using the procedures prescribed by the manufacturer in the draft technical manual and subject the test item to the applicable procedures of MTP 10-2-503, and the following:

NOTE: Inadequacy of instruction in the draft technical manual regarding the preparation of the test item for transport should be reported by EPR.

a. Subject the test item to the vibration procedures as outline in method 279 of Federal Test Method Standard 101a:

1) For the first 15 minutes, maintain the amplitude constant at 1/2 ± 1/32 inch (1 ± 1/16 inch double amplitude); and either vary the frequency to repeatedly sweep at 2 minutes per octave from 2 to 5 cps and return, or maintain for 5 minutes each at constant frequencies of 2, 3, and 5 cps.
2) For the last 105 minutes, maintain the relationship between frequency and amplitude shown in Figure 2, as the frequency is progressively changed from 5 cps to the maximum and returned. The maximum frequency shall be determined on the basis of test item weight as per Figure 3. For apparatus in which the frequency and the amplitude may be varied continuously, sweep the frequency at not less than 2 minutes per octave.
3) For apparatus in which the amplitude may be varied only in increments, the amplitudes of the platform motion, frequencies, and durations shall be as listed in Figure 4.



NOTE: 1. Plane of Solid Frame is parallel to plane of axis of pulley rotation and perpendicular to surface of water.

2. D = test depth of diver in feet.

Figure 1. Simulated Swimming Test Arrangement.

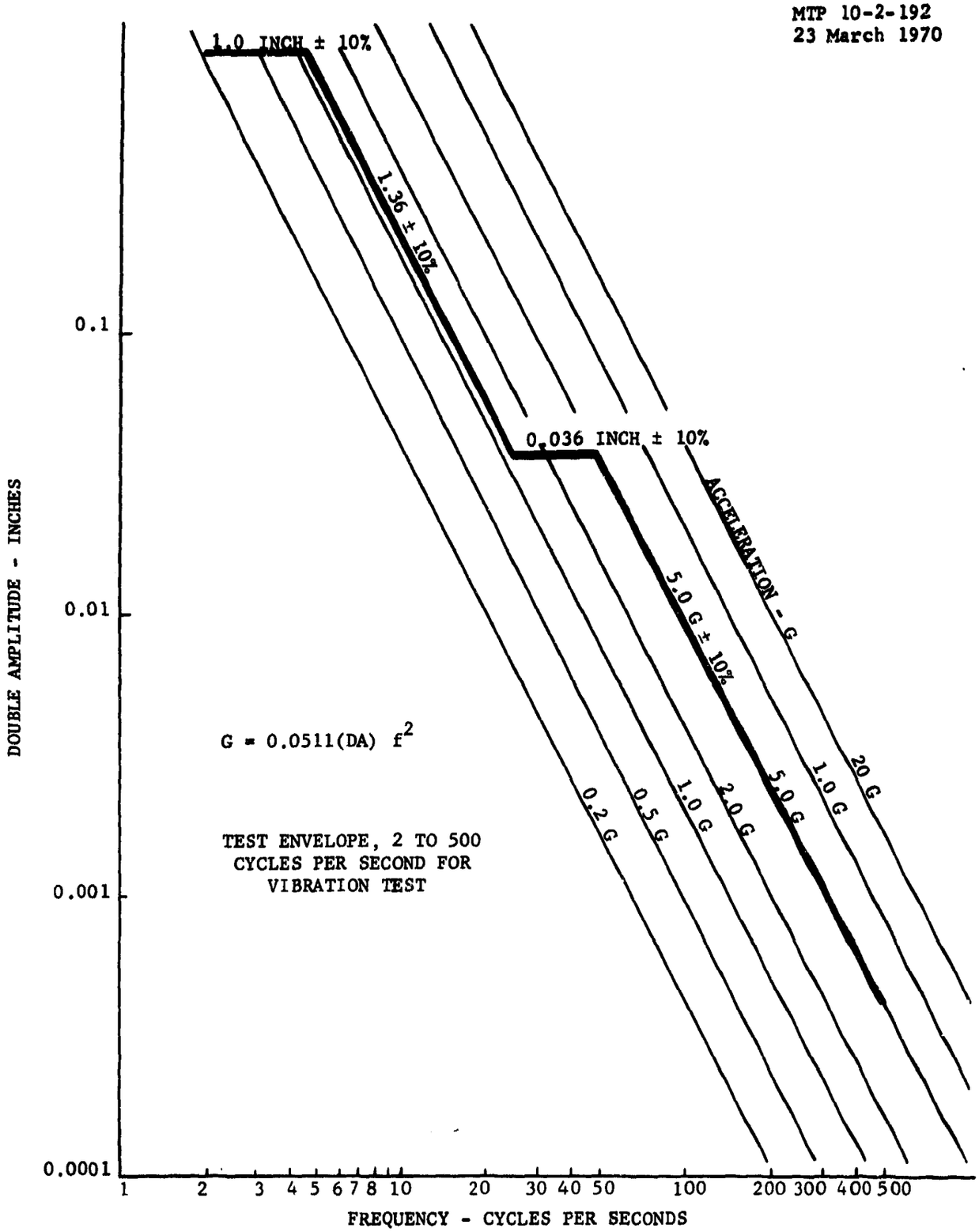


Figure 2. Test Envelope, 2-500 cps (for Vibration Test)

Weight of Specimen	Maximum Frequency
lb.	cps.
100 or less	500
300 or more	50
Between 100 and 300	725 (2.25 x weight)

Figure 3. Frequency-Weight Relationship

	FREQUENCY (f), either		
Double Amplitude Constant	Sweep Between f/1.23 and 1.23f	Constant	Minimum Duration of Vibration
Inches	Hertz	Hertz	Seconds
0.673	5.0 to 7.56	6.15	70
.295	7.56 to 11.44	9.30	70
.129	11.44 to 17.30	14.07	70
.055	17.30 to 26.6	21.60	70
.036		32.70	70
.036		49.50	35
.036	26.6 to 50.0		105
.036	50.0 to 26.6		105
.036		49.50	35
.036		32.70	70
.055	26.6 to 17.30	21.60	70
.129	17.30 to 11.44	14.07	70
.295	11.44 to 7.56	9.30	70
.673	7.56 to 5.0	6.15	70

Either use the constant frequency or, preferably, sweep the range of frequency at not less than 2 minutes per octave.

Figure 4. Incremental Amplitude Changes.

b. Upon completion of the test, perform the following:

1) Visually inspect the test item for damage and record cracks, breaks, ruptures, etc.
2) Subject the test item to the performance test procedures of paragraph 6.2.6.2.

6.2.8 Stress Tests

6.2.8.1 Coated Fabric Diving Equipment Components

Test specimens of coated fabric components as applicable for material stress in accordance with the following method prescribed in FED-STD-191:

6.2.8.1.1 Burst Strength - Perform the burst strength test as prescribed in method 5120, and record the following:

a. Test item component involved
b. Test item-specimen position data
c. Burst strength for each specimen

6.2.8.1.2 Stretch Test - Perform the stretch test as prescribed in method 5100, and record the following:

a. Test item component involved
b. Test item-specimen position data
c. Breaking strength for each specimen

6.2.8.1.3 Adhesion Test - Perform the adhesion test as prescribed in method 5970, and record the following:

a. Test item component involved.
b. Test item-specimen position data.
c. 5 highest peak load forces registered to the nearest 0.1 lb. per 2 inch width for each specimen.

6.2.8.1.4 Strapped Seam Adhesion Test - Perform the strapped seams adhesion test as prescribed in method 5962, and record the following:

a. Test item component involved
b. Test item-specimen position data
c. 5 highest peak loads registered on the autograph for each specimen
d. Width of the seam, in inches

6.2.8.1.5 Resistance to Blocking - Determine the resistance to blocking of applicable coated fabric components as prescribed in method 5872, and record the following:

a. Test item component involved.
b. Test item-specimen position data.
c. Extent of blocking on a scale of 4, as prescribed in paragraph 4.4 of the test procedure (method 5872).

6.2.8.2 Rubber Diving Equipment Components

Perform material testing procedures on applicable rubber components of the test items (in accordance with the following method) prescribed in FED-STD-601:

6.2.8.2.1 Tensile Strength - Subject applicable test item components specimen to tensile strength test as prescribed in method 4111, and record the following:

a. Test item component involved
b. Test item - specimen position data
c. For each specimen:

1) Breaking force applied
2) Cross sectional area of the unstretched specimen
3) Type specimen (ring; dumbbell or straight)

6.2.8.2.2 Elongation - Subject applicable test item components specimen to the ultimate elongation test as prescribed in Method 4121 and record the following:

a. Test item component involved
b. Test item - specimen position data
c. For each specimen:

1) Type specimen (ring, dumbbell or straight)
2) Distance between benchmarks at moment of specimen rupture
3) Distance between knife edges of bench marker

6.2.8.2.3 Tear Resistance - Subject applicable test item components specimen to the tear resistance test as prescribed in Method 4211, and record the following:

a. Test item component involved
b. Test item - specimen position data
c. For each specimen:

1) Type of specimen
2) Tearing force applied (maximum)
3) Thickness of specimen

6.2.8.2.4 Hardness - Subject applicable test item components specimen to the hardness test as prescribed in Method 3021, FED-STD-601, and record the following:

a. Test item component involved
b. Test item - specimen position data
c. For each specimen:

1) Scale reading
2) Time interval before reading instrument

6.2.9 Accelerated Aging

6.2.9.1 Coated Fabric

a. Subject specimen taken from applicable components of the test item to accelerated aging as prescribed in Method 5850 of FED-STD-191 for a period of 7 days.
b. Upon completion of the accelerated aging perform the stretch

test procedures of paragraph 6.2.8.1.2.

6.2.9.2 Rubber Components

a. Subject specimen taken from applicable components of the test item to accelerated aging as prescribed in Method 7221 FED-STD-601 for a period of 46 hours at a temperature of 90° ± 1.1°C.

b. Upon completion of the accelerated aging perform the tensile strength procedures of paragraph 6.2.8.2.1.

6.2.10 Magnetic Effect

Subject metallic components of the test item, as applicable to magnetic effect test procedures of MIL-M-19595a and record the following for each component tested:

a. Equipment component under test
b. Axis used as reference
c. Temperature
d. Background magnetic field strength
e. Orientation relative to reference axis at maximum variation
f. Change in magnetic field strength

6.2.11 Human Factors Evaluation

Determine the adequacy of design and performance characteristics of the test item and its associated equipment in terms of conformance to appropriate human factor engineering design criteria by performing the applicable procedures of MTP 10-2-505 and evaluating the following:

a. User's comfort while wearing test item and his ability to perform required tasks with minimal restrictions.

b. Adequacy of instruction markings.

c. Ease of operating valves and other devices.

d. Ease of removing weighted shoes, weighted belts, or SCUBA harnesses quickly in emergency situations.

6.2.12 Value Analysis

Value analysis shall be performed to determine whether the diving equipment item has any nonfunctional, costly, or "nice-to-have" features as stated in USATECOM Regulation 700-1.

a. During operation and maintenance of the test item, observations shall be made to determine whether it incorporates any features that could be eliminated without compromising its performance, reliability, durability, maintainability or safety.

b. During conduct of the test, testing personnel shall be informally questioned regarding any features of the test item that may be eliminated without decreasing its functional value. All user comments regarding value analysis shall be recorded in the daily log.

c. Each test team member shall study the test item during use and shall draw on his experience and background in value analysis to comment in the daily log regarding elimination of unnecessary features.

6.2.13 Quality Assurance

Determine the quality of the test item as described in the applicable sections of MTP 10-2-511.

6.3 TEST DATA

6.3.1 Preparation for Test

6.3.1.1 Pre-Test Inspection

Record the following:

a. Evidence of package damage or deterioration
b. Identification markings including:

    1) Manufacturer
    2) Number and date of contract
    3) Date of manufacture
    4) Type of diving equipment

c. For each shipping package

    1) Contents
    2) Weight, in pounds
    3) Overall dimensions, in feet and inches, of:

        a) Length
        b) Width
        c) Height

    4) Cubage, in cubic feet

d. For entire test item package (if more than one shipping package):

    1) Weight, in pounds
    2) Cubage, in cubic feet

e. Type and adequacy of packing material
f. Defects in:

    1) Construction
    2) Material
    3) Workmanship

g. Evidence of damage and/or wear
h. Existence of shortages

i. Deviations in marking from MIL-STD-130
j. Any discrepancies in physical condition of helmets, including:

1) Threads for connecting to breastplates
2) Watertight telephone connections
3) Faceplate hinge
4) Safety lock

k. Any evidence of rust or verdigris on metal surfaces
l. Any dry, hard, or cracked leather
m. For rubber or rubberized components, evidence of:

1) Oil or grease on surface
2) Permanent set, cracks, or breaks at folds

n. Defects on surface seams or edges of test item components
o. Presence of:

1) Identification plate(s)
2) Pressure ratings marked on cylinders
3) Caution instructions plate(s)
4) Handling and service instructions plates(s)

6.3.1.2 Physical Characteristics

Record the following for each test item component under test, as applicable.

a. Data collected as described in applicable sections of MTP 10-2-500
b. Weight of all fabric specimen in grams per square inch
c. For cotton and woolen fabric

1) Wales and courses per inch
2) pH

6.3.1.3 Operator Training and Familiarization

Record data collected as described in the applicable sections of MTP 10-2-501.

6.3.2 Test Conduct

6.3.2.1 Safety

Record the following throughout the test:

a. Adequacy of the design of SCUBA divers' weights and cylinder harnesses for quick release in case of emergency.
b. Any dangerous or unsafe condition resulting from inadequate features.
c. Any dangerous or unsafe features on test item.
d. Adequacy of safety features on test item.
e. Suggestions to improve existing safety precautions.

6.3.2.2 Maintenance

Record the data collected as described in the applicable sections of MTP 10-2-507.

6.3.2.3 Hydrostatic Tests

6.3.2.3.1 Divers' Dress Leakage -

Record the following:

a. Initial pressure reading (psig).
b. Pressure reading after five (5) minutes (psig).
c. Bubbling as evidence of leakage

6.3.2.3.2 Permanent Expansion of Cylinders and Manifolds -

Record the following:

a. Initial volume of test item before pressurization
b. Any evidence of leakage
c. Final volume of test item after depressurization

6.3.2.3.3 Hydrostatic Pressure Resistance of Coated Fabric Seams -

Record the following:

a. Rate of application of pressure.
b. Amount of constant hydrostatic pressure applied, and length of time applied.
c. Pressure reading after 5 minutes pressurization.

6.3.2.4 Sizing and Fitting

Record the following for each test item being evaluated:

a. Item under test.
b. Fit.
c. Obviousness of preparation required or adequacy of instructions, as applicable.
d. Ease of performing required adjustments.
e. Compatibility with other equipment.
f. Non-interference with the performance of required tasks.

6.3.2.5 Donning and Doffing

Record the following for each test item studied:

a. Item under test.
b. Any apparent difficulties observed during donning and/or doffing.
c. Subjective opinions of each test subject regarding the ease and safety of donning and doffing the test item with respect to the following, if applicable:

1) Suitability of fastening and adjustments
2) Ability to effect fastenings and adjustments
3) Ease of donning and doffing over clothing and other equipment
4) Apparent difficulties observed by recorder

6.3.2.6 Performance Tests

6.3.2.6.1 Components Performance Tests -

Record the following:

a. For Safety Air Non-return Value Test:

1) Absence of positive closure of valve at any low-pressure application.
2) Any bubbling as evidence of leakage at any low-pressure setting.
3) Defective valve seating under 1 psig forward pressure.
4) Any evidence of leakage of pressure container.

b. For Helmet Air-Regulating Escape Valve (Exhaust Valve) Test:

1) Pressure at which valve opens when hand wheel is open
2) Malfunctioning of valve when chin button is depressed
3) Pressure at which valve opens when hand wheel is shut

c. For Air Hose for Diving Helmets:

1) Any hose damage resulting from burst test
2) Any hose damage resulting from proof test

d. For Absorbent Canister:

Record the following:

1) Fresh absorbent used.
2) Any difficulty encountered in filling the canister.
3) Adequacy of canister inlet and outlet screens.
4) Any continuous bubbling as evidence of leakage.
5) Amount of impurities in breathing medium at each sampling interval during breathing test.
6) Any evidence of channeling or wetting at completion of breathing test.
7) Test subjects' comments regarding any excessive breathing resistance encountered.
8) Design deficiencies encountered (too small, improper shape, etc).

e. For Air Hose for Lightweight Diving Outfit any hose damage resulting from burst test.

f. For valves (Miscellaneous):

1) Valve tested
2) Deficiencies in performance

g. For Low pressure Warning Device Operation:

1) Initial pressure applied to manifold
2) Excessive breathing resistance experienced at initial pressure
3) Pressure reading at which air flow stops

6.3.2.6.2 Systems Performance Tests -

Record the following for each dive:

a. For surface supplied equipment:

1) Actual or simulated depth in feet
2) Water temperature at depth in °F.
3) Duration of dive in minutes
4) Difficulties encountered and action taken
5) Evidence of leakage
6) Test subject comments regarding:

a) Safety
b) Functional performance

b. For SCUBA the test subjects comments regarding:

1) Excessive breathing resistance experienced at any depth, attitude on high pressure side on the demand regulator.
2) Suitability of the diving equipment.
3) Difficulties encountered.

6.3.2.7 Transportability

Record the following for each test performed:

a. Test performed (drop, vibration, etc)
b. Damage noted in post-test visual inspection
c. Data collected as described in paragraph 6.2.6.2

6.3.2.8 Stress Tests

6.3.2.8.1 Coated Fabric Equipment Components -

Record the following:

a. For Burst Strength for each component:

1) Component involved
2) Specimen position/location data
3) For each specimen the burst strength in pounds

b. For Stretch Test for each component:

1) Component involved
2) Specimen position/location data
3) For each specimen the breaking strength in pounds

c. For Adhesion for each component:

1) Component involved.
2) Specimen position/location data.
3) For each specimen the 5 highest peak forces registered on the autograph.

d. For Strapped Seam Adhesion for each component:

1) Component involved
2) Specimen position/location data
3) For each specimen

a) Seam width
b) 5 highest peak forces registered on the autograph

e. For Resistance to Blocking for each component:

1) Component involved.
2) Specimen position/location data.
3) For each specimen blocking as per Method 5872 FED-STD-191 Paragraph 4.4 scale of 4.

6.3.2.8.2 Rubber Diving Equipment Components -

Record the following, as applicable:

a. For Tensile Strength test for each component:

1) Component involved
2) Specimen position/location data
3) For each specimen:

a) Breaking force applied
b) Cross sectional area (unstretched)
c) Type specimen

b. For Elongation for each component:

1) Component involved
2) Specimen position/location data
3) For each specimen:

a) Distance between benchmarks at moment of rupture
b) Distance between knife edges of bench marker

c) Type specimen

c. For Tear Resistance of each component:

1) Component involved
2) Specimen position/location data
3) For each specimen:

a) Tearing force applied (maximum)
b) Thickness
c) Type of specimen

d. For Hardness test of each component:

1) Component involved
2) Specimen position/location data
3) For each specimen:

a) Scale reading
b) Time interval before reading instrument

6.3.2.9 Accelerated Aging

6.3.2.9.1 Coated Fabrics -

Record the following:

a. Component involved
b. Data collected as described in paragraph 6.2.8.1.2

6.3.2.9.2 Rubber components -

Record the following:

a. Component involved
b. Data collected as described in paragraph 6.2.8.2.1

6.3.2.10 Magnetic effect

Record the following:

a. Component involved
b. Axis of reference
c. Temperature in centigrade
d. Background magnetic field strength in millioersteds
e. Change in magnetic field in millioersteds

6.3.2.11 Human Factors Evaluation

Record the following:

a. Data collected as described in applicable sections of MTP 10-2-503.
b. Test subject's comments regarding his comfort while wearing test item and his ability to perform required tasks with minimal restrictions.
c. Adequacy of instruction markings.
d. Ease of operating valves and other devices.
e. Ease of removing weighted shoes, weighted belts, or SCUBA harnesses quickly in emergency situations.

6.3.2.12 Value Analysis

Record the following throughout the test:

a. Nonfunctional or unnecessary features
b. Component involved
c. Test personnel comments

6.3.2.13 Quality Assurance

Record data collected as described in the applicable sections of MTP 10-2-511.

6.4 DATA REDUCTION AND PRESENTATION

6.4.1 General

Data obtained during the conduct of the tests shall be summarized, making use of photographs and charts, as appropriate. Test data for each diving equipment item tested shall be obtained, summarized, and evaluated as required.

Data obtained for each performance characteristic shall be compared with technical performance characteristics specified in the QMR's, SDR's, or other developmental criteria. Test data obtained from different types of diving equipment undergoing the same test shall be compared. Compare the results of the Performance Tests (6.2.6) conducted initially and after the Transportability Tests.

In addition to charts and photographs, presentation shall include narrative reports on all phases of the test.

6.4.2 Weight of Textile Materials

Calculate the weight of textile materials as follows:

$$\text{weight per square yard, oz} = \frac{\text{Weight of specimen in grams} \times 36\text{"/yard} \times 36\text{"/yard}}{\text{area of specimen in square inches} \times 28.35 \text{ grams/oz}}$$

6.4.3 Permanent Expansion Test

Calculate the permanent expansion of cylinders and manifolds as follows:

$$\text{Percentage expansion} = \frac{Va - Vb}{Vb} \times 100$$

Where:
Va is the volume of the test item after pressurization
Vb is the volume of the test item before pressurization

6.4.4 Tensile Strength

Calculate the tensile strength of the test specimen as follows:

Dumbbell and straight specimen
$$\text{Tensile strength, pounds per square inch} = \frac{F}{C}$$

Ring specimen
$$\text{Tensile strength, pounds per square inch} = \frac{F}{2C}$$

Where:
F = breaking force, pounds
C = cross section area of unstretched specimen, square inches

and:
$$\text{cross section area, C, in square inches} = \frac{0.155W}{D \times L}$$

where:
W is the weight of the specimen in air, grams
D is the density of the specimen, grams per centimeter
L is the length of the specimen in centimeters

6.4.5 Elongation Test

Calculate the ultimate elongation of the test specimen as follows:

a. Dumbbell and straight specimen:

$$\text{Ultimate elongation percent} = \frac{D_1 - D}{D} \times 100$$

Where:
D is the distance between knife edges of the bench markers
D_1 is the distance between bench markers at the moment of rupture of the specimen

b. Ring specimen

$$\text{Ultimate elongation, percent} = \frac{L_1 - L}{L} \times 100$$

Where:
L is the inside circumference of the unstretched specimen
L_1 is the inside circumference of the stretched specimen

6.4.6 Tear Resistance Test

Calculate tear resistance of test specimen as follows:

$$\text{Tear Resistance in pounds per inch of thickness} = \frac{F}{T}$$

Where:
F is the maximum tearing force, pounds
T is the thickness of the specimen, inches

6.4.7 Accelerated Aging Test

Calculate the change in strength of test specimen as a result of aging as follows:

$$\text{change in strength, percent} = \frac{O-E}{O} \times 100 \text{ or } \frac{E-O}{O} \times 100$$

Where:
O = value before aging
E = value after aging

6.4.8 Safety

A Safety Release Recommendation shall be submitted in accordance with USATECOM Regulation 385-6 based on the data collected related to safety.

UNCLASSIFIED
Security Classification

DOCUMENT CONTROL DATA - R & D

Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author) US Army Test and Evaluation Command (USATECOM) Aberdeen Proving Ground, Maryland 21005	2a. REPORT SECURITY CLASSIFICATION Unclassified 2b. GROUP ----------

3. REPORT TITLE
U. S. Army Test and Evaluation Command Materiel Test Procedure 10-2-192, Commodity Engineering Test Procedure, - "Diving Equipment (Helmets, Belts, Divers Dress, etc.).

4. DESCRIPTIVE NOTES (Type of report and, inclusive dates)
Final

5. AUTHOR(S) (First name, middle initial, last name)
----

6. REPORT DATE 23 March 1970	7a. TOTAL NO. OF PAGES 32	7b. NO. OF REFS 25
8a. CONTRACT OR GRANT NO DA-18-001-AMC-1045(R) b. PROJECT NO AMCR 310-6 c. d.	9a. ORIGINATOR'S REPORT NUMBER(S) MTP 10-2-192 9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report) ----------	

10. DISTRIBUTION STATEMENT
This document is subject to special export controls and each transmittal to foreign governments or foreign nationals,-WITH THE EXCEPTION OF AUSTRALIA, CANADA, AND UNITED KINGDOM,-may be made only with prior approval of HQ,USATECOM.

11. SUPPLEMENTARY NOTES ----------	12. SPONSORING MILITARY ACTIVITY Headquarters US Army Test and Evaluation Command Aberdeen Proving Ground, Maryland 21005

13. ABSTRACT

This Engineering Test Procedure describes test methods and techniques necessary to determine the technical performance and safety characteristics of diving equipment, as described in Qualitative Materiel Requirements (QMR), Small Development Requirements (SDR), Technical Characteristics (TC), and their suitability for service tests. The diving equipment is categorized as: surface-supplied diving equipment; self-contained diving equipment, including self-contained underwater breathing apparatus (SCUBA); and diving accessories.

DD FORM 1 NOV 65 1473 (PAGE 1)
S/N 0101-807-6811

UNCLASSIFIED
Security Classification

A-31408

UNCLASSIFIED
Security Classification

14 KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Engineering Test						
Diving Equipment						
Test Procedures						
Test Methods and Techniques						

DD FORM 1 NOV 68 1473 (BACK)
S/N 0101-807-6821

UNCLASSIFIED
Security Classification

A-31409