4 March 1971

Materiel Test Procedure 10-2-213
General Equipment Test Activity

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

DIVING EQUIPMENT, SCUBA

1. OBJECTIVE

This document provides test methodology and testing techniques to determine the technical performance and safety characteristics of self-contained underwater breathing apparatus (SCUBA) and associated tools and equipment as described in Materiel Needs (MN), and to determine the item's suitability for service tests.

2. BACKGROUND

a. Lightweight, reliable, SCUBA diving gear is required to equip US Army divers for a variety of underwater tasks. These tasks include secret approach to and departure from target areas, engineer inspection and minor repairs to off-shore POL facilities; armor, infantry or engineer reconnaissance of deep water vehicle fording sites; and transportation or engineer shallow water salvage and boat repair operations. Individual or personal equipment required for these tasks include the following: SCUBA (open and closed circuit), snorkel, face mask, swim fins, fin shoes, wet and dry suit, diving belt with weights and knife, depth gauge, wrist watch, life preserver, storage container, spear gun, camera, pressure gauge, and lantern.

b. Three types of SCUBA gear are available: open-circuit, closed circuit, and a combination of open and closed circuit. In the open circuit system, the diver inhales from the storage tank gas supply via a pressure reducing mechanism (regulator) and exhales each breath into the surrounding water. In a closed system, the diver inhales from a breathing bag. He exhales each breath back to the breathing bag through a purifying canister. None of the gas supplied to the system is intentionally exhausted to the water. In the combination open and closed system, inhaled gases are a mixture of filtered exhaled gas and gas from the bottled supply.

c. Each type of SCUBA system has advantages and disadvantages in comparison to the remaining two systems. The open system uses the greatest volume of breathing gas for a given period of dive, but, since only the bottled gas is inhaled, build-up of carbon dioxide or nitrogen in the breathing media is impossible. The open system is, therefore, safest of the three

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

and thus most often used. The closed system exudes a minimum of gas and is used where dives of maximum duration and/or secrecy of operation is required. However, complexity of operation is increased resulting in greater likelihood of the diver receiving an excess of carbon dioxide (hypercapnia), insufficient oxygen (anoxia), or oxygen at excessive pressure (resulting in oxygen poisoning). The combination open and closed system is somewhere between the open system and closed system with regard to safety and duration of diving period. Since it provides neither greatest diver safety nor minimum possibility of detection, this system finds little use.

d. Both the open and closed SCUBA have several possible configurations and can use several different breathing media. The most common open circuit SCUBA systems are a continuous flow and a demand regulator system. The continuous flow type is manually adjusted to provide a continuous flow of air to a mask worn by the diver. Excess air and the diver's exhalation is vented to the water via an exhaust valve. Since the air flow has to meet the demands of an inspiration, and, since it continues during expiration, the storage cylinder must provide at least twice the diver's minute volume of respiration. The demand regulator system reduces this waste by delivering compressed air to the diver only during inhalation. This is accomplished by a special low-pressure regulator that maintains the breathing system at ambient depth pressure opening to deliver air with slight negative pressure at the start of inspiration and remaining open only until the end of inspiration. Exhaled gases are routed through an exhaust valve in the diver's mask or mouthpiece to the surrounding water. The pressure of exhaust gases must be referenced to the water pressure at the regulator to keep the system balanced.

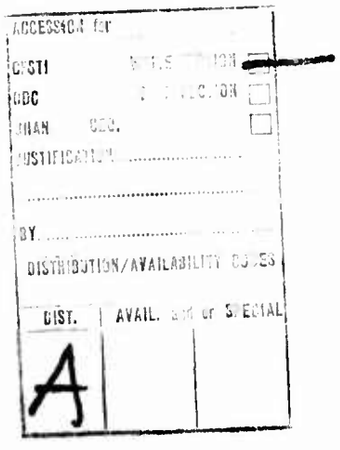
e. The breathing media in an open SCUBA system is generally compressed air (oxygen 21%, nitrogen 79%) or a mixture of oxygen and helium. Compressed air is used when diving to depths of 200 feet. Beyond that depth, a mixture of oxygen and helium is used to avoid the greatly increasing effects of nitrogen narcosis, an intoxication effect much like that produced from alcohol, but resulting from breathing pressurized nitrogen.

f. The closed SCUBA system most commonly uses either oxygen or a mixture of oxygen and helium as the breathing media. When pure oxygen is used,the diver inhales oxygen and exhales oxygen and carbon dioxide. The carbon dioxide is removed in a carbon dioxide absorbant canister thus reducing the volume (and pressure) of the gas in the system. The diver then manually admits more oxygen from the storage cylinder into the breathing bag to restore the system pressure, or, a pressure regulator is used to automatically restore the lost oxygen. The depth of diving is severely limited in this system since breathing pure oxygen at increased pressure rapidly induces a condition known as oxygen poisoning. The limiting pressure factor is approximately two atmospheres which limits pure oxygen closed system diving to about 33 feet. Beyond this depth, danger of convulsion due to oxygen poisoning is greatly increased.

g. To offset the effects of increased pressure, a mixture of oxygen and helium is used as the breathing media. Generally, the proportion of oxygen and helium is fixed to allow prolonged diving within strictly defined diving depths. Recently, a more sophisticated system has been developed that allows the diver much greater range of diving depth by continuously adjusting the proportion of oxygen and helium in the breathing media such that the partial pressure of oxygen is always equal to approximately one atmosphere. This is accomplished by controlling the percentage of oxygen in the breathing media as diving depth is varied. For example, at five atmospheres pressure (132 feet) a gas mixture of 20 percent oxygen has an oxygen partial pressure of one atmosphere. At 10 atmospheres (297 feet), the gas mixture may not contain more than 10 percent oxygen for an oxygen partial pressure within one atmosphere. An oxygen sensing and metering device referenced to ambient pressure maintains the oxygen partial pressure at one atmosphere within the breathing bag, and a demand regulator meters the helium required to maintain the total pressure within the breathing bag equal to the ambient. Two cylinders, one containing helium and one containing oxygen, are required for this system.

3. REQUIRED EQUIPMENT

a. Vise with wood lined jaws to protect material being held.
b. Hydraulic pump, hydrostatic pressure meter (0-5000 psi graduations), burettes, water jackets and equipment shown in Figure 1.
c. Wood samples (2x4), 3/4 inch nylon and hemp rope as required.
d. Laboratory clock and watch movement calibrating standard.
e. Turntable calibrated in one-degree increments from 0 to 360 degrees.
f. Calibration standard compass.
g. Stop watch.
h. Portable hydrostatic test chamber with at least one transparent wall to enable viewing item being pressure tested.
i. Pivotable-sphere hazemeter (See Figure 2.)
j. Drop-impact machine with an impact weight of 16.3 pounds, 1.9-inch spherical radius, mounted on slide-wires. Total height of slide-wire guide for weights shall not be less than five feet.
k. Photometer with remote pick-up probe calibrated against an NBS standard lamp of the specified color temperature. The photometer shall read-out directly in foot-candles, and be properly compensated to agreement with the luminosity function, y, of the standard observer.
l. Suitable test site.
m. Accessories required for camera to complete underwater photography mission. Accessories, dependent upon the camera supplied, may include watertight box, flash



attachment, viewing and focusing mechanism, etc.

n. Buoy, 200-foot line, and depth markers in 25-foot increments from 0 to 200 feet. (Used in completing camera and depth gauge tests.)
o. Water tank of sufficient size to completely immerse SCUBA system in water.
p. Thermocouples and indicating devices, as required.
q. Suitable underwater targets for spear gun test.
r. Water manometer with pressure differential columns of at least six inches in height.
s. Mechanical breathing device, respiration rate adjustable from 10 to 30 breaths/min., tidal volume adjustable from 0 to 3 liters/ breath, and containing sufficient indicating devices to monitor air-flow rate, inhalation and exhalation breathing resistance. The breathing machine shall also exhale carbon dioxide in an amount adjustable from 0 to 2 liters/min. and shall have provisions for mounting external carbon dioxide and oxygen sensing devices at the breather inhalation port.
t. An oxygen sensing device; a carbon dioxide sensing device. Each device should be capable of being mounted at the inhalation port of the mechanical breather and indicate percentage of respectively monitored gas in inhaled media to an accuracy of 0.1 percent.
u. Decompression chamber.
v. Environment control chamber.

4. REFERENCES

A. USAMC Pamphlet 706-134 Engineering Design Handbook: Maintainability Guide for Design.
B. USATECOM Regulation 70-23 Research and Development; Equipment Performance Reports (EPRs).
C. USATECOM Regulation 385-6 Safety: Verification of Safety of Materiel During Testing.
D. USATECOM Regulation 700-1 Quality Assurance: Value Engineering.
E. USATECOM Regulation 750-15 Maintenance of Supplies and Equipment: Maintenance Evaluation During Testing.
F. USAGETA Document Human Factors Evaluation Data for General Equipment (HEDGE).
G. FED-STD-406 Plastics, Methods of Testing.
H. FED-STD-601 Rubber, Sampling and Testing.
I. MIL-STD-129 Marking for Shipment and Storage.
J. MIL-STD-130 Identification Marking of US Military Property.
K. MIL-STD-794 Parts and Equipment, Procedures for Packaging and Packing of.
L. MIL-STD-810 Environmental Test Methods.

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M. MIL-STD-1472 Human Engineering Design Criteria for Military Systems, Equipment and Facilities.
N. MIL-STD-33586 Metal, Definition of Dissimiliar.
O. MIL-L-16383 Life Preserver, CO_2, Inflatable, Underwater Demolition Team.
P. MIL-M-19595 Magnetic Effect Limits for Non-magnetic Equipment Used in the Proximity of Magnetic Influence Ordnance.
Q. MIL-P-116 Preservation, Methods of.
R. MIL-T-704 Treatment and Painting of Material.
S. MIL-W-6101 Wire; Spring Steel.
T. TM 55-375 Military Diving.
U. MTP 10-2-132 Camera Set, Still Picture.
V. MTP 10-2-194 Life Preservers.
W. MTP 10-2-500 Physical Characteristics.
X. MTP 10-2-501 Operator Training and Familiarization.
Y. MTP 10-2-502 Durability.
Z. MTP 10-2-503 Transportability.
AA. MTP 10-2-505 Human Factors Evaluation.
AB. MTP 10-2-507 Maintenance Evaluation.
AC. MTP 10-2-508 Safety.
AD. MTP 10-2-511 Quality Assurance.
AE. MTP 10-2-512 Reliability.

5. SCOPE

5.1 SUMMARY

This materiel test procedure describes the following tests to be conducted on SCUBA systems.

a. Preparation for Test - A determination of the condition of the test item upon its arrival and other preparatory procedures to be completed prior to active testing. These procedures consist of the following:

1) Packaging and test item inspection
2) Inventory check.
3) Physical characteristics inspection.
4) Operator training and familiarization.
5) Pre-operational checks.

b. Compressed Gas Cylinder - An evaluation to determine ability of cylinder to withstand internal pressure without expanding excessively or bursting.

c. Knife Test- An evaluation to determine the ability of the knife to withstand normal operating abuses.

d. Watch Test - An evaluation to determine the watch accuracy and ability to resist corrosion and withstand hydrostatic pressure.

e. Compass Test - An evaluation to determine compass accuracy and ability to resist corrosion and withstand hydrostatic pressure.

f. Face Mask Test - An evaluation to determine transmissibility and resistance to shatter of face mask safety glass.

g. Electric Lantern Test - An evaluation to determine luminous intensity of the lantern and the decay rate of its power supply. In addition, the ability of the lantern to resist corrosion and withstand hydrostatic pressure is also evaluated.

h. Pencil and Slate Test - An evaluation to determine the test item's suitability for underwater communications.

i. Depth Gauge Test - An evaluation to determine the gauge accuracy and ability to resist corrosion and withstand hydrostatic pressure.

j. Camera Test - An evaluation to determine the camera's operating characteristics and its suitability for underwater photography.

k. Wet and Dry Suit Tests - An evaluation to determine the suitability and adequacy of the suits in supporting diving missions.

l. Life Preserver Test - An evaluation to determine agreement of life preserver characteristics with the referenced standard life preserver characteristics.

m. Storage Container Test - An evaluation to determine ability of container to provide watertight stowage and its ability to be sunk without the use of external weighing devices.

n. Spear Gun Test - An evaluation to determine underwater performance characteristics of the spear guns and 12-gauge power heads.

o. SCUBA Test - An evaluation to determine the performance characteristics of the SCUBA system, its major components, and its safety devices.

p. Simulated Environment Test - An evaluation to determine the SCUBA system's ability to withstand specific environmental conditions. The tests in this section include the following:

1) Extreme Low Temperature Test (-65^0F, -53.9^0C).
2) Extreme High Temperature Test (155^0F, 68.3^0C).
3) Fungus Test.
4) Salt Fog Test.
5) Sunshine Test.

q. Electromagnetic Interference - An evaluation to determine the magnetic field intensity of the assembled SCUBA system.

r. Durability - An evaluation to determine ability of test item to withstand normal operational stresses without failure.

s. Transportability - An evaluation to determine the ability of the test item to withstand the forces that it will experience during normal transport by train, truck or airplane.

t. Maintenance Evaluation - To determine and verify the maintenance/maintainability characteristics and requirements of the test item; an appraisal of the design and of the maintenance test package, and the calcualation of indicators which express the effects of the preceding aspects.

u. Reliability - An evaluation to determine the probability that the test item will perform its intended function for a specified interval under stated conditions.

v. Safety - An evaluation to determine the safety characteristics and possible hazards of the test item.

w. Human Factors Evaluation - An evaluation to determine the adequacy of the design and performance characteristics of the test item and associated equipment in terms of conformance to accepted human factors engineering design criteria.

x. Value Analysis - An evaluation directed at analyzing the primary function and features of the test item for the purpose of reducing the cost of the test item without compromising performance and safety characteristics.

y. Quality Assurance - An evaluation to appraise the quality of workmanship and degree of material freedom from defects and flaws.

5. LIMITATIONS

These procedures are applicable to open and closed SCUBA systems and their accessories as defined in this document.

6. PROCEDURES

6.1 PREPARATION FOR TEST

6.1.1 Initial Inspection

6.1.1.1 Shipping and Packaging Inspections

a. Examine the preservation and packaging of the SCUBA and support equipment and determine any non-conformance with MIL-P-116 and MIL-STD-794. The container should also be marked in accordance with MIL-STD-129.

b. Record the following:

1) Evidence of damage or deterioration to packaging or shipping components and materials.
2) All identification markings.
3) All printed material accompanying the test item and agreement with test item markings.

Remove the test item from its shipping carrier, if applicable, and record the following:

a. Equipment, time and personnel required.

b. Comments regarding the method and materials used to secure the test item.

6.1.1.2 Test Item Inspection

The test item should be marked in accordance with MIL-STD-130 and in addition, should be visually inspected for evidence of defects, damage and wear in its manufacturing, materials, and workmanship. In particular, the following will be considered.

6.1.1.2.1 General -

a. All equipment should be nonmagnetic and constructed of corrosive resistant materials.

b. Equipment should be a color that minimizes visual detection of diver in water.

c. Dissimilar metals as defined by MIL-STD-33586 shall not be placed in contact with each other.

d. All equipment be designed with standard connectors that permit recharging cylinders from air compressors with integrated purifying filters.

e. Record evidence of the following:

1) Missing components, draft technical manual, or support equipment.
2) Incorrect assemblage or alignment of components.
3) Rusty or improperly protected metal surfaces; cracking, poor welding, or deformation of joints and seams.

4) Fasteners, slides, clasps, springs; broken, inoperative or rusted.
5) Rubber or rubberized components oil or grease coated; occasion wherein rubber components are not free from permanent set, cracks or breaks at folds.
6) Occasion wherein metal surfaces, seams, glass, plastic surfaces, rubber and rubberized fabric surfaces, and hardware are not free from roughness, irregularities and other defects.

f. For each compressed air cylinder record the following:

1) Volume (cubic feet).
2) Rated pressure (psi).
3) Date of 1st inspection certification.
4) Visual condition (cylinders should be free from rust, dents, scratches and be externally treated and painted in accordance with MIL-T-704, type A.)
5) If cylinder is pressurized to less than 15 psig, inspect the cylinder for internal corrosion. If corrosion is found, have cylinder cleaned and filled with appropriate breathing media.

NOTE: Never leave cylinder pressurized to less than 15 psig. Failure to observe this note can cause internal corrosion of cylinder.

g. A diving belt should be supplied constructed of nylon or similar durable material having corrosive resistant buckle and provisions for holding lead weights and a knife sheath. The buckle shall allow quick divestment of the diving belt, but be designed to preclude inadvertent operation of the release mechanism. The belt shall hold two and four pound weights and be so designed as to impede movement of the weights in the belt.

h. A high quality knife with a blade approximately six inches long, constructed of high strength corrosive resistant steel should be supplied. A floating handle to prevent loss of knife is desirable. The knife blade will be bayonet shaped, with one cutting and one sawing edge and have a hand guard. A suitable sheath for the knife with provision for attaching the sheath to the diving belt shall also be provided.

i. A depth gauge should be supplied in accordance with requirements for the US Navy Standard Gage, Depth, Wrist: MKI; 1844080 Rev A. In addition the gauge may be modified with an adjustable dial or indicator. This feature will allow the gauge to be calibrated for dives either below or above sea level.

j. A wrist watch with the following characteristics should be supplied:

1) Be capable of operating at depths to 160 feet below water's surface.
2) Have a luminous dial calibrated into minutes and hours.
3) Have a warning indicator to show moisture penetration into the watch body.
4) Have an outer rotating bezel dial graduated in 60 one-minute increments.
5) Have a non-corrosive container and a non-corrosive, non-slip wrist band.

k. A face mask designed to cover the eyes and nose with the following characteristics should be provided:

NOTE: Proper fit is absolutely essential in using the face mask. The mask should be made of soft rubber and contoured to fit a wide variety of face types. Determine proper fit by positioning the face mask over the eyes and nose and partially evacuating the mask by inhaling through the nose. The mask should stay on the face without any additional support (including headstrap). Press the mask hard and uniformly against the face: the applied pressure should be uniformly distributed over the face; the mask should not collapse to an extent that will cause the face plate to contact the face; no portion of the mask should pinch, bruise, or cut the face.

1) The face plate should be constructed of safety glass of at least 80 percent transmissibility.
2) The mask should have a head harness with adjustable straps to hold the mask securely to the diver's head.

l. A wrist compass with the following characteristics should be provided:

1) Be capable of operating at depths to 160 feet below water's surface.
2) Have a calibrated luminous dial that indicates direction within $\pm$ 3 degrees.
3) Have a non-corrosive watertight container and a non-corrosive, non-slip wrist band.

m. Swim fins, fin shoes, and snorkel.

Swim fins should be open heeled, ridged, reinforced, rigid blade of UDT type. Fin shoes should be hard sole, canvas top, laced or coral shoes. Snorkel should be adaptable to attachment on face

mask strap, equipped with a soft, smooth, easily gripped mouthpiece "J"-shaped, constructed of rubber, neoprene, or plastic, contain no devices to keep water out of tube, and be of a length that cuases the snorkel to not rise more than 14 inches above the mouth level of snorkel-using diver.

n. A wet suit should be provided that will maintain safe body temperatures for divers operating in water temperatures to 40 degrees Fahrenheit. The wet suit may be constructed of gas blown neoprene. The wet suit should have the following additional characteristics.

1) Be durable and resist tears and cuts.
2) Be lined to permit rapid donning and doffing by diver.
3) Be close fitting to respective diver yet offer minimum resistance to movement.
4) Be equipped with zippers in both arms and legs to facilitate donning and doffing.

o. A dry suit including hood, gloves and boots should be provided that will maintain safe body temperatures in extremely cold water (from 27 to 40 degrees Fahrenheit). The dry suit should have the following characteristics:

1) Be watertight at depths to 160 feet below the water's surface yet be designed to permit a maximum freedom of movement.
2) Be lined with a material that permits rapid donning and doffing of suit.
3) Be durable and resist tears and cuts.

p. A slate and pencil of simple construction and suitable for writing underwater. The slate and pencil should be joined with a lanyard and the slate should have provision for attachment to the diving belt.

q. A camera with the following characteristics shall be supplied:

1) Be capable of operating at depths to 160 feet below the water's surface.
2) Have variable shutter speeds from 1/30 to 1/500 of a second.
3) Have variable lens openings from f2.5 to f16.
4) Be capable of using black and white or color 35mm film with ASA film speeds from 25 to 2000.
5) Be equipped with an electronic underwater flash attachment.
6) Have a non-corrosive watertight container.
7) Have a case for carrying on land.

r. An electric lantern with the following characteristics shall be supplied:

1) Be capable of operating at depths to 160 feet below the water's surface for two hours without recharging or replacing electrical supply.
2) Be of minimum size and weight consistant with operating requirements.
3) Have a hook or similar device for attachment to the diving belt and a lanyard for attachment to the diving belt to preclude loss.
4) Produce 80,000 candle power from a fresh power supply. Light decay after two hours use of power supply should not exceed 25,000 candle power.
5) Have a non-corrosive watertight container.

6.1.1.2.2 Open Circuit SCUBA -

Each open circuit SCUBA will be completely open circuited and consist of the items described below:

a. Two compressed air tanks with each tank of not less than 72.4 cubic feet capacity. The tanks will provide, as a minimum, a two hour supply of breathable air for a diver working 10 feet below the water surface.

b. A manifold connecting the cylinders to the regulator; the manifold should have a single on-off air-flow control valve, two 3900 psig blow-out discs, and a manually released air reserve mechanism set to restrict breathing when cylinder pressure drops between 300 to 500 psig. Activating the manual release mechanism should remove the restriction and allow complete exhaustion of the cylinder.

c. A two stage, demand type, single or double hose regulator with pressure indicator visible to diver while diver wears the equipment underwater.

d. An integrated nylon harness with quick release buckles designed for the following:

1) Quick divestment of SCUBA.
2) Preclusion of inadvertent divestment of SCUBA.
3) Allowance for rapid life preserver inflation.

e. A mouthpiece or face mask with inhalation and exhalation input/output ports. Check valves may be employed to prevent flooding breathing tubes and to reduce system dead space by properly channeling the flow of exhaled gases.

f. Hoses as required. All hoses should consist of non-kinking, flexible, corrugated or bellows type rubber or neoprene hose. The hoses should be resistant to deterioration due to exposure to sunlight, salt water and oil or other hydrocarbons, and shall have a safe working pressure of 250 psi. Each hose should have at least one swivel type connector that will allow alignment of hose to be changed to eliminate torques either in the hose or connected hardware.

g. Adequate auxiliary hardware such as a sintered bronze filter at the air inlet of the first stage regulator, and a protective cap of plastic or other suitable material for the air inlet. The protective cap should be secured to the yoke fitting by some flexible means to preclude its loss when not in use.

h. Exhaust valve located near demand regulator or pressure referenced to regulator.

6.1.1.2.3 Closed Circuit SCUBA -

Each closed circuit SCUBA shall be the completely closed recirculating type (permit minimum escape of gases) and consist of the items described below:

a. One or two tanks (as required) to provide, as a minimum, sufficient breathing media for a diver to descend, work for 30 minutes at 80 percent of maximum depth allowed by the SCUBA design, ascend at 60 feet per minute, and decompress as appropriate for depth and duration of dive.

b. A breathing bag fabricated and dimensioned in accordance with the applicable MN or military specifications. The bag shall have provisions to accomodate a demand regulator, and an oxygen sensing and metering device (if used).

c. A carbon dioxide absorbent canister with pressure-relief valve set to open between four to five psig. The canister shall be of sufficient size and baffling that when filled with the required carbon dioxide absorbent chemical it will remove carbon dioxide from exhaled gases for a minimum diving period of two hours.

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.

1) Examine the canister, and record any of the following design deficiencies:

   a) Too small: absorbent would be rapidly exhausted.
   b) Improper shape: CO_2 could be blown through, and path would soon be exhausted; 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.

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

d. If used an oxygen measuring and metering device that regulates the percentage of oxygen in the closed system breathing media as a function of the diving depth. This action is accomplished by comparing the percentage of oxygen in the system against that required for the depth to dive and metering the required oxygen from the storage tank into the breathing bag.

e. A manifold connecting the cylinders to the regulator; the manifold shall have a single on-off air-flow control valve, two 3900 psig blow-out discs, and a manually released air reserve mechanism set to restrict breathing when cylinder pressure drops between 300 to 500 psig. Activating the manual release mechanism should remove the restriction and allow complete exhaustion of the cylinder.

f. A two stage, demand type, single or double hose regulator with pressure indicator visible to diver while diver wears equipment underwater.

g. An integrated nylon harness with quick release buckles designed for the following:

1) Quick divestment of SCUBA.
2) Preclusion of inadvertent divestment of SCUBA.
3) Allowance for rapid life preserver inflation.

h. A mouthpiece or face mask with inhalation and exhalation input/output ports. Check valves shall be employed to prevent flooding system and to properly channel flow of gases.

i. Hoses as required. All hoses should consist of nonkinking, flexible, corrugated or bellows type rubber or neoprene hose. The hoses should be resistant to deterioration due to exposure to sunlight, salt water and oil or other hydrocarbons, and shall have a safe working pressure of 250 psi. Each hose should have at least one swivel type connector that will allow alignment of hose to be changed to eliminate torques either in the hose or connected hardware.

j. A manual bypass valve should be provided when an automatic oxygen metering mechanism is employed. When activated, the bypass valve shall allow oxygen from the cylinder to bypass the metering mechanism and freely enter into the breathing bag.

6.1.2 Inventory Check

Verify completeness of the test item and associated parts and material with the Basic Issue Item List (BIIL) and file an Equipment Performance Report (EPR), if required.

6.1.3 Physical Characteristics

The physical characteristics of the test item shall be determined by performing the applicable sections of MTP 10-2-500.

6.1.4 Operator Training and Familiarization

Test personnel should undergo the applicable procedures of MTP 10-2-501.

6.1.5 Preoperational Checks

Perform the following:

a. Depreservation and assembly - remove all preservatives from the test item and assemble SCUBA and mission support systems in preparation for normal operation.

b. Cleaning - breathing media systems shall be cleaned before use in accordance with TM 55-375, paragraph 1.10.11.

c. Lubrication - no oil or grease should be used on any portion of the SCUBA system. If lubrication of any part is required, follow recommendations in draft technical manual as to lubricating procedure and type of special lubricant to be used.

d. Filters - if used, verify that all air filters are clean and properly installed.

6.2 TEST CONDUCT

NOTE: Prepare an Equipment Performance Report (USATECOM Regulation 70-23 for any malfunction incurred in completing the following procedures.

6.2.1 Compressed Gas Cylinder

Each compressed gas cylinder should be hydrostatically tested at a pressure equal to 5/3 of the pressure for which the cylinder was designed as specified below:

a. The wire wrapping of nonshatterable cylinders should be removed prior to hydrostatic testing. This removal is necessary to prevent possible loosening of the wire binding strips or the wire winding during such testing. In addition, rust is occasionally found under the wire winding.

b. The cylinder is placed in a vise, and the water jacket cover is installed using a rubber gasket. See Figure 1. The cylinder and cover are then assembled to the water jacket. All pressure joints must be made up carefully to assure absolute watertightness.

c. The water jacket is then filled with water, leaving the petcock open until the water flows out of it. The petcock is then closed and the level in the burettes adjusted to read exactly zero.

d. The specified internal hydraulic pressure shall then be gradually applied to the cylinder by means of the pump and maintained for 30 seconds.

e. The burettes shall be observed carefully. If the level fluctuates, the test must be repeated, using a test pressure 100 psi higher than that of the previous test. If a third test is run, the test pressure should be 100 psi higher than for the second test. If the third test fails, the cylinder should be discarded.

f. At the end of the test period the volumetric expansion of the cylinder shall be determined by observing the amount of water displaced into the burettes. Then the internal pressure on the cylinder should be gradually released and the permanent volumetric expansion determined by observing the amount of water displaced into the burettes.

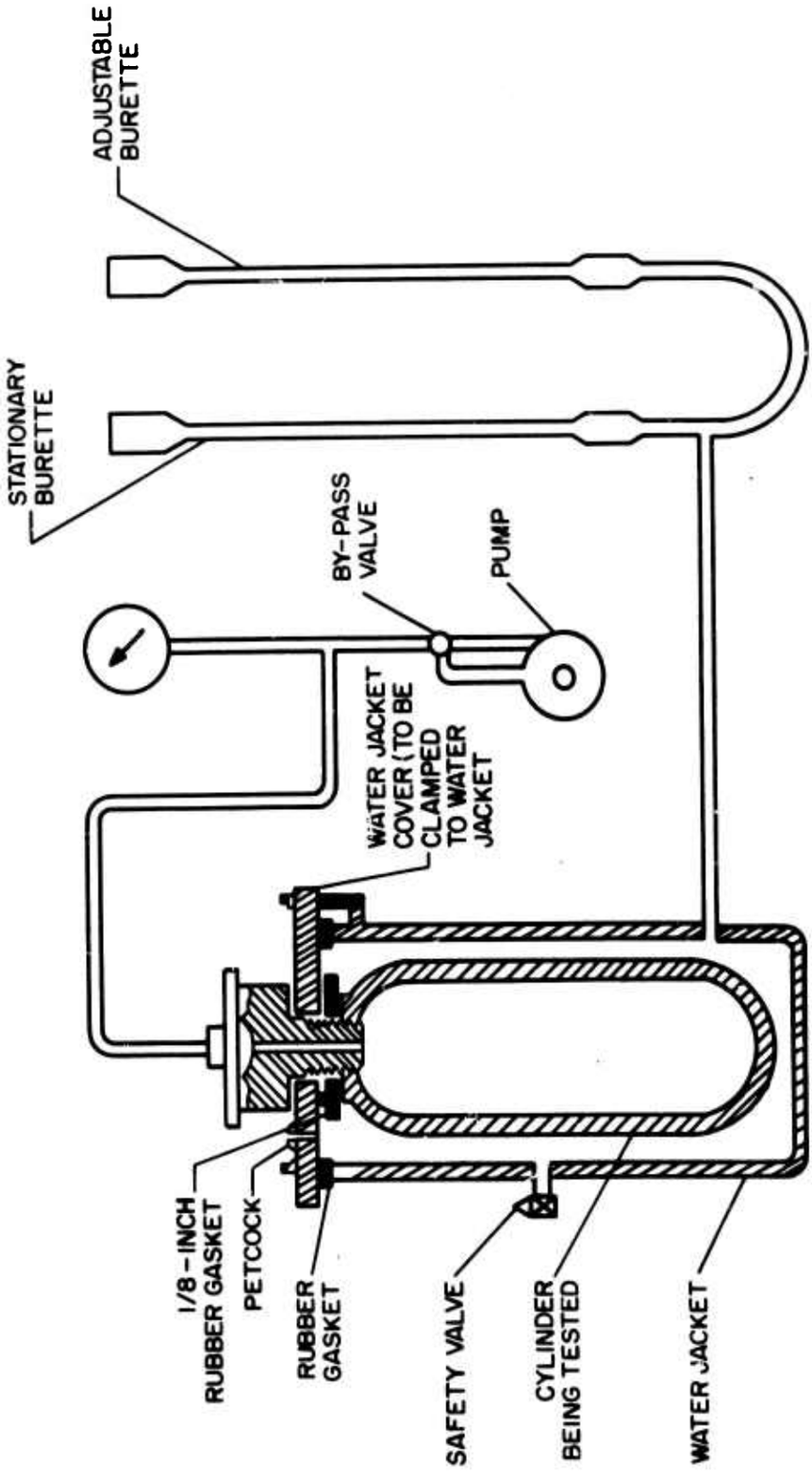

Figure 1: Apparatus for Proof Testing Cylinders

g. The cylinder should then be removed from the water jacket, placed in a vise, and the water jacket cover removed.

h. If the permanent expansion of the cylinder is more than 10 percent of the total expansion the cylinder should be drained, and tagged with a "Rejected" tag, showing reason for the rejection of the cylinder.

i. If the percentage of permanent expansion is 10 percent or less the cylinder is satisfactory.

j. Rewind the nonshatterable cylinders with 0.029-tinned music wire conforming to Specification MIL-W-6101.

6.2.2 Knife Test

This test should allow the testor to qualitatively determine the suitability of the knife for use in diving missions.

a. Measure the blade length.

b. Place knife in tank of water; knife should not sink.

c. Obtain samples of the following materials: nylon and hemp rope 3/4 inch in diameter, 2 by 4 inch hardwood planks.

d. Use the knife to cut and saw the samples described in step c. for a period of 30 minutes. At the end of the work period, qualitatively determine and record loss of cutting efficiency resulting from the test. Repeat the test and record loss of cutting efficiency after each 30-minute period until cutting efficiency of knife is reduced by 50 percent.

e. Place the knife blade between two one-inch planks of wood and clamp the blade in a vise with the handle positioned upward and perpendicular to the vise table. Slowly and carefully pull handle towards tester until blade snaps or the blade is bent at a 90-degree angle.

f. Subject the knife to the salt-fog test referenced in paragraph 6.2.16.4 for a period of 96 hours.

6.2.3 Watch Test

a. Calibrate watch using laboratory clock and watch movement calibrating standard. Record accuracy of watch in a 24-hour period.

b. Place watch in a hydrostatic test chamber. Fill chamber with water and increase water pressure to 103 psia. After two hours, drain test chamber and remove watch.

c. Subject watch to the salt-fog test referenced in paragraph 6.2.16.4.

d. Measure and record watch accuracy during a 24-hour period using equipment described in step a.

6.2.4 Compass Test

a. Align a turntable calibrated in one degree increments (0 through 360 degrees) to N. magnetic using a recently calibrated magnetic compass of known and superior performance (with respect to the expected test item performance).

b. Replace calibration compass with test item. Rotate turntable, in turn, to each cardinal point (90, 180, 270 and 360 degrees). Record test item error at each point. Record time for test item indicator to stabilize following each 90 degrees of rotation.

c. Center test item on a card calibrated in one degree increments, 360 degrees for one complete rotation of card. Place both card and test item in a hydrostatic test chamber and align card such that N. indicator of test item coincides with 0-degree mark on card. The hydrostatic test chamber shall be on casters or other suitable device to allow one complete rotation of the test chamber. Scribe four marks, each 90 degrees apart, on the floor around the periphery of the test chamber. Scribe a mark on the test chamber to coincide with one of the four peripheral marks. Slowly fill test chamber with water without moving test item or card. After test chamber is filled with water, view test item while increasing pressure of water to 103 psia. Record fluctuations of N. indicator with increasing water pressure; record final deviation of N. indicator of test item from 0-degree mark of card.

d. Rotate test chamber in 90-degree increments. At each 90-degrees of rotation, record test item error; record time for test item indicator to stabilize following each 90 degrees of rotation.

e. Drain hydrostatic test chamber; subject the compass to the salt-fog test referenced in paragraph 6.2.16.4.

f. Repeat steps a. and b.

6.2.5 Face Mask Test

The fit of the face mask has already been evaluated in completing the procedure of paragraph 6.1.1.2.1. Completing the procedures of this paragraph will determine the transmissibility and shatter resistance of the face mask safety glass.

6.2.5.1 Safety Glass Transmissibility

Use method 3022 of FED-STD-406, which is summarized by the following procedures, to determine the ratio of transmitted to incident luminous flux of the safety glass.

a. Obtain a pivotable-sphere hazemeter, or equivalent, as illustrated by Figure 2. Use illuminant "A" as the light source (2,848 degrees K).

b. Prepare a test item visor material specimen approximately 1.5 inches in diameter minimum and small enough to be tangent to the integration sphere. Record specimen diameter and thickness to the nearest 0.0001 inch.

c. Insert the specimen as shown by Figure 2.

d. Apply power to the source lamp. Record the voltage and current values required to obtain the proper color operating temperature.

e. Conduct the test cycle a minimum of five times. A test cycle is identified as the determination of four values involving various combinations of the specimen, light trap, and reflectance standard. Consult the table below:

TEST-CYCLE TABLE I

Reading designation	Specimen in position	Light trap in position	Reflectance standard in position	Quantity represented
T_1	No	No	Yes	Incident light.
T_2	Yes	No	Yes	Total light transmitted by specimen.
T_3	No	Yes	No	Light scattered by instrument.
T_4	Yes	Yes	No	Light scattered by instrument and specimen.

Record T_1, T_2, T_3, and T_4 for each test cycle (minimum of five value sets).

6.2.5.2 Safety Glass Shatter Resistance

a. Obtain a drop-type impact machine with an impact weight of 16.3 pounds, 1.9 inch spherical radius, mounted on slide wires. Total height of slide-wire guide for weight shall not be less than five feet.

b. Position mask with safety glass installed face downward on a peripheral supporting ring concentric with point of weight impact on base of impact machine.

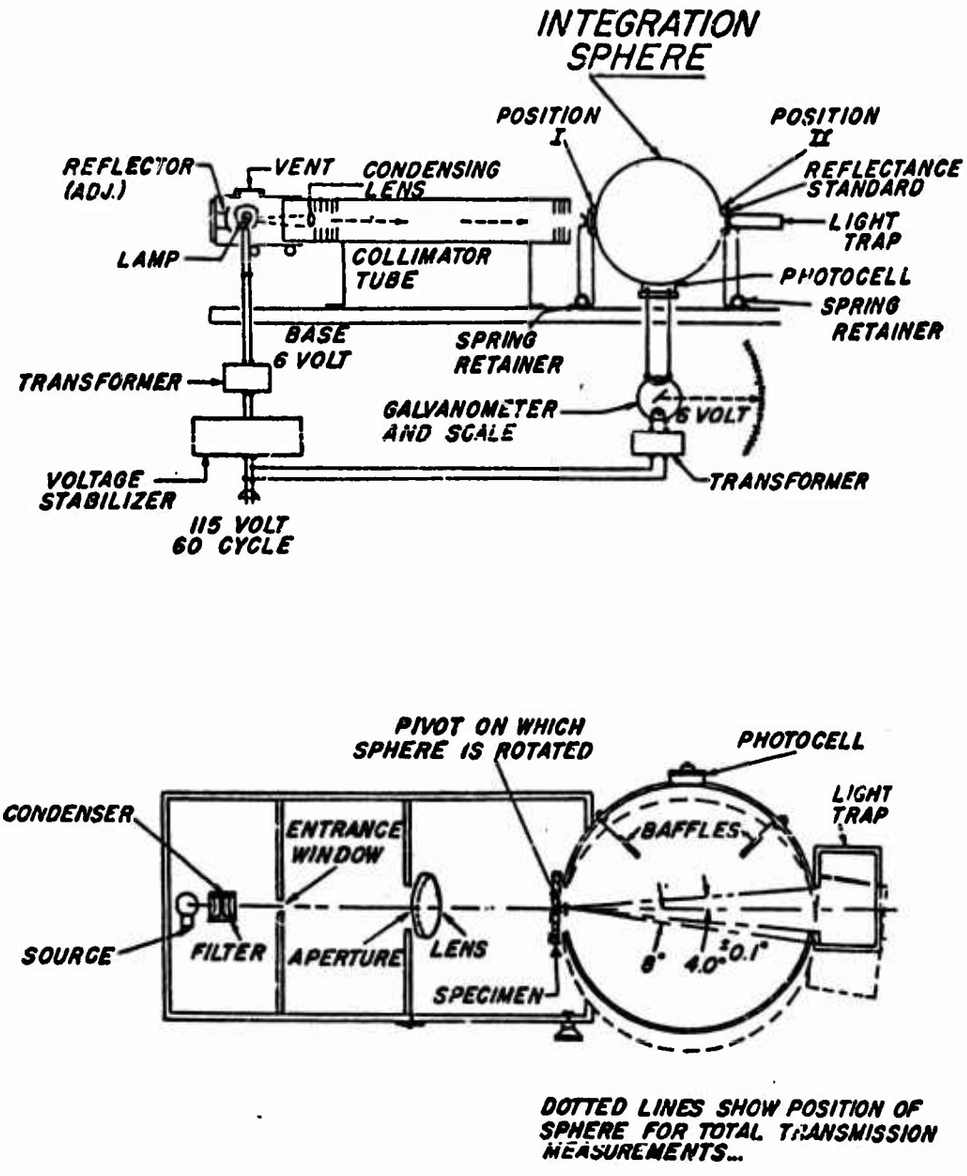

FIGURE 2: TYPICAL PIVOTABLE-SPHERE HAZEMETER AS REQUIRED FOR DETERMINATION OF TOTAL LUMINOUS TRANSMITTANCE AND DIFFUSE LUMINOUS TRANSMITTANCE.

c. Elevate drop weight a height such that sufficient force will be generated by the falling weight to penetrate the safety glass; drop weight on glass.

d. Repeat step c. a number of times with an equal number of face mask samples using different weight drop heights. Assess and record the safety glass ability to withstand shock and its resistance to shattering when penetrated by the falling weight.

6.2.6 Electric Lantern Test

a. Set-up the test item for normal operation in a room with unobstructed vertical walls suitable for detecting the horizontal beam limits.

b. Obtain a photometer equipped with a remote pick-up probe calibrated against an NBS standard lamp of the specified color temperature. The photometer shall read-out directly in foot-candles, and be properly compensated to agreement with the luminosity function, y, of the standard observer.

c. With the test item in a stationary position, level, and aimed at an appropriate distance, D, from the vertical wall, illuminate the wall and move the photometer probe through the light beam (at the wall surface). Locate the beam center; measure and record foot-candles.

d. Place test item in a hydrostatic pressure test chamber. Energize test item and direct beam to vertical wall. Fill test chamber with water. Using photometer, locate beam center; measure and record foot-candles. Slowly increase pressure of water to 103 psia; record deviations of photometer indications with increasing pressure.

e. Drain hyrostatic test chamber and remove test item. Subject test item to the salt-fog test referenced in paragraph 6.2.16.4. Repeat steps a., b., and c.

f. If the foot-candle measurement obtained in step e. agrees with that obtained in step d., proceed to step g. If otherwise, refer to the draft technical manual to repair performance degradation, then, proceed to step g.

g. Repeat steps a., and b. Repeat the procedures of step c. for a test period of two hours. Record foot-candles after each 15 minute interval until two hour test period has expired.

6.2.7 Pencil and Slate Test

Test the pencil and slate for suitability in underwater communications by placing the pencil and slate in a tank of water, then, complete writing and erasing operations on the slate.

6.2.8 Depth Gauge Test

a. Subject the depth gauge to the salt-fog test referenced in paragraph 6.2.16.4.

b. Test the depth gauge for accuracy and pressure resistance in 25-foot increments during the 200-foot diving mission described in paragraph 6.2.9.

c. Select accessible diving sites that range in altitude from 0 to 10,000 feet above sea level. Using the test methodology referenced in step b. and diving tables supplied with the gauge to calibrate the gauge for diving up to 10,000 feet above sea level, record depth gauge readings in 50-foot foot increments over the selected range of diving altitude. Record, also, corresponding depth marker indications.

6.2.9 Camera Test

a. With the camera set for surface (out-of-water) operation determine and record the camera's operating and performance characteristics using the applicable tests in MTP 10-2-132. The various tests should be completed with shutter speed varied from 1/30 to 1/500 of a second, lens opening varied from f2.5 to f16, and film speed varied from ASA 25 to 2000.

b. With the camera set and protected for underwater photography and with a suitable viewing mechanism and electronic underwater flash attachment installed, take pictures of depth markers from 0 to 200 feet, in 25-foot increments. Use a standard, performance proven SCUBA system to complete the picture taking mission.

6.2.10 Wet and Dry Suit Tests

6.2.10.1 Dry Suit Leakage

Inflate each portion of the dry suit with air to a pressure of one psig for five minutes to determine watertightness. Submerge the suit portions in a tank of water. Note and record any bubbling as evidence of leakage.

6.2.10.2 Hydrostatic Pressure Resistance of Coated Fabric Seams (Dry Suit).

Perform the following test in accordance with FED-STD-601, method 10511.

a. Place the coated side of the fabric next to the water, with the edge of the seam normally exposed to the water 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 a hydrostatic pressure head of 50 centimeters of water has been reached. The seams shall withstand this pressure for 5 minutes.

6.2.10.3 Sizing and Fitting

Determine proper fit of diving suits underwear, woolen gloves, socks, and gymnasium shoes, on a wide variety of body and head sizes while allowing the wearers maximum freedom of movement by completing the following steps:

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 in accordance with the imprinted or labeled sizing.

c. Each man shall don, in proper sequence, the test items and equipment required for general diving.

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

e. Each man shall then perform routine operational and mission-oriented tasks.

f. Rate each test item for fit acceptability and task non-interference by test items.

6.2.10.4 Donning and Doffing

a. Prepare for study as in paragraph 6.2.10.3, steps a. and b.

b. Record any apparent difficulties observed during donning and/or doffing.

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

1) Suitability of fastenings 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.

6.2.10.5 Insulation Test

a. Obtain a test chamber that contains a water tank that will permit a test subject to sit immersed in water over his head. Means shall be provided to control and monitor the water temperature form 27 to 95 degrees Fahrenheit.

NOTE: Ensure that test subject is of good health and is suffering from no physical discomfort at time of test (such as respiratory illness, agitation, etc.).

b. Obtain a test subject; issue him a complete wet suit and SCUBA outfit of proven ability to perform its prime function.

c. Have the test subject don the SCUBA outfit and wet suit and instrument him with thermocouples as follows:

1) On great toe.
2) On each hip.
3) Four places on trunk.

CAUTION: The test must be continuously monitored by technical personnel. If at any time the skin temperature at any point on body drops to 40°F. or there is any other indication of impending cold injury, the test will be immediately stopped.

d. Have test subject enter test chamber water tank and sit on a chair such that water level is over his head. The water temperature shall be 40°F. For the next 30 minutes read and record, in one minute intervals, the skin temperature at the six selected monitor points.

e. Repeat steps a., b., c., and d. with a second test subject using a complete dry suit, a SCUBA system of proven ability to perform its prime function, and a water temperature of 27°F. (Water in tank shall be sufficiently salted to keep from freezing water.)

6.2.10.6 Tear Resistance Test

a. Perform test method 4211 of FED-STD-601 on the wet and dry suits and record all results.

b. Age the suit in accordance with method 7211 of FED-STD-601.

c. Repeat step a.

6.2.11 Life Preserver Test

The life preserver supplied with the SCUBA system shall be equal to the US Navy Standard Life Preserver, CO_2 Inflatable, UDT Team-MIL-L-16383, FSN 4220-276-8929. The life preserver shall be tested using applicable procedures in MTP 10-2-194.

6.2.12 Storage Container Test

a. Assemble container for watertight storage of contents.

b. Float storage container in a tank of water for a period of 24 hours.

c. Flood floatation chamber(s) of container such that container rests on bottom of water tank with at least two inches of water over the container. After a 24-hour period, raise container and examine storage compartment for evidence of moisture.

d. With the container set for watertight storage, place container in a hydrostatic test chamber. Fill test chamber with water and flood floatation chamber(s) of container. Increase hydrostatic pressure of water to 103 psia. After four hours, drain hydrostatic test chamber; remove container and examine storage compartment for evidence of moisture.

6.2.13 Spear Gun Test

Weapons provided for protection against dangerous marine life include three-rubber spear guns and 12-gage power heads mounted on spears. The spear guns are useful to a target range of approximately 20 feet. The 12-gage power head is actuated upon target contact and acts to drive the spear further into the target. The spear guns are best tested by using them to drive spears into targets at ranges of 5, 10, 15, and 20 feet at a nominal diving depth of 25 feet. The tests should be performed both with and without the power heads on any standard underwater targets of determined and controlled penetration resistance.

6.2.14 Pressure Gage Test

a. Subject the pressure gauge to the salt-fog test referenced in paragraph 6.2.16.4.

b. Obtain a recently calibrated pressure gauge (0 to 3000 psig with graduations corresponding to the test item) of known and superior performance (with respect to the expected test item performance).

c. Obtain a regulated high pressure air source capable of being varied from 0 to 3000 psig and controlled to within three psig.

d. Using a tee connector and any other required fittings, couple the reference standard and test item to the air source.

e. Activate air source and vary air pressure from 0 to 3000 psig in increments corresponding to the test item graduations. For each pressure increment, record indication of standard gauge and test item.

6.2.15 SCUBA Tests

6.2.15.1 Component Performance Tests

6.2.15.1.1 Air Hose Burst Test

Perform the following test on each air hose.

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

b. Apply 1000 psig for two minutes to hose to burst test the hose.

6.2.15.1.2 One-way Check Valves

Perform the following test on each valve.

a. Connect the valve to an airtight container that is equipped with a pressure gage. The valve is positioned to admit air into the container but restrict air flow from the container.

b. Apply one-half psig via the valve to the airtight container.

c. Observe that the valve is properly seated and that the airtight container remains pressurized to one-half psig.

d. Repeat steps b. and c. using three psig.

6.2.15.1.3 Manifold Assembly

a. Connect the manifold to a regulated high pressure air source (3900 $\pm$ 390 psig) with the output air-flow control valve shut off. The air source shall not be active.

b. Activate the air source and slowly increase output air pressure. Observe that no air leaks from air-flow shut-off valve and that one or both 3900 psig blow-out discs on manifold release when air pressure reaches 3900 $\pm$ 390 psig.

6.2.15.1.4 Low Pressure Safety Relief Test

a. Assemble the low pressure breathing system. Connect system to a regulated low pressure air compressor.

b. Slowly increase air pressure and note pressure required to activate low pressure safety release valve (should be approximately 150 psig).

c. Slowly decrease air pressure and note closing pressure of safety release valve.

d. Set air pressure midway between the safety valve opening and closing pressures. Check for air leakage through the valve.

6.2.15.1.5 Hose and Regulator Group Leakage Test

a. Connect a water manometer by means of a tee and a proper fitting to the facepiece adapter and the breathing tube and attach a source of vacuum, with a shut-off valve, to the other end of the tee. Increase the vacuum gradually until the demand valve opens. Read the manometer at the instant the valve opens. Shut off air or oxygen at the pressure regulator and exhaust residual air or oxygen from the low pressure hose, the demand regulator and the breathing tube until the manometer reads 2" $\pm$ 1/2" of water, or as specified in other technical requirements. Close the valve to the vacuum source. Failure of the manometer to maintain the level for a minimum of 10 seconds indicates leakage in the breaking tube assembly.

b. Pressurize and immerse the apparatus under water; emission of bubbles indicates leakage. Brush the connection between the low pressure hose and demand regulator with soap solution; persistent bubbling indicates leakage.

6.2.15.1.6 Regulator Hydrostatic Test

The high pressure regulator is statically tested by connecting the regulator to a high-pressure hydraulic pump, then, slowly increasing the internal hydrostatic pressure of the regulator to 5000 psig.

6.2.15.1.7 Pressure Relief Valve Test (Carbon dioxide absorbent canister)

Repeat procedures of paragraph 6.2.14.1.4 for safety value on carbon dioxide absorbent canister and record all results. (Value should activate between 4 or 5 psig).

6.2.15.2 System Performance Tests

6.2.15.2.1 Open System Mechanical Breathing Test

a. Obtain a mechanical breathing apparatus capable of producing 30 respirations/min., at a flow rate of 90 liters/min., and equipped with suitable instruments to measure inhalation and exhalation pressure, flow rate, and flow resistance. The breathing machine shall also be capable of continuously "exhaling" from 0 to 2 liters/min. of carbon dioxide.

b. On SCUBA system, replace compressed air tank with a regulated high-pressure air source capable of continuously providing compressed air at 90 liters/min., at a pressure of 2000 psig.

c. Place the high-pressure air source and SCUBA system in an environment control test chamber. Mount the SCUBA system mouthpiece or face mask (whichever is used) on the dummy head of the mechanical breather. Set the air temperature within the test chamber to 95°F and complete the following tests:

1) Activate the SCUBA and air source (2000 psig). Set the mechanical breather for the respiratory rate of 30 breaths/min. and an air flow rate of 90 liters/min. Submerge the SCUBA system (less air source) and head of mechanical breather in a tank of water in test chamber. Check the entire system for air leaks, especially about coupling points, air hoses, valves, and mouthpiece. Also note and record whether air bubbles discharged into the water would impair diver's visibility. Remove SCUBA system and mechanical breather head from water. Vary air-flow rate from 15 to 90 liters/min. in 15 liter increments. Record inhalation and exhalation pressure and flow resistance as a function of air-flow rate.
2) Repeat step 1) at an ambient air temperature of 61°F and 27°F.
3) Repeat steps 1) and 2) with a respiratory rate of 10 breaths/min.
4) Install a cylinder pressure gage of 50 psi graduations from 0 to 3000 psi on each compressed gas cylinder used in the SCUBA system under test. Pressurize each cylinder with the appropriate gases to the normal working limit of the cylinder. Remove the high-pressure air source and connect the pressurized gas cylinder(s) in the SCUBA system.
5) Set mechanical breathing apparatus for a respiratory rate of 30 breaths/min. and a flow rate of 45 liters/min. Ambient air temperature is 61°F. Measure and record inhalation and exhalation pressure, and flow resistance as a function of decreasing cyclinder pressure (50 psig increments). Air flow should virtually stop at a cylinder pressure of 400 $\pm$ 100 psig. After air flow stops, activate air reserve valve and continue test until tank(s) is exhausted.

6.2.15.2.2 Closed System Mechanical Breathing Test

a. If a pure oxygen closed breathing system or a closed system using mixed gases of fixed relative proportion is under test, replace SCUBA system compressed gas tank with a regulated high-pressure air source capable of continuously providing compressed air at 90 liters/min., at a pressure of 2000 psig. If a closed, self-mixing helium-oxygen system is under test, disconnect the helium and oxygen storage cylinders from the SCUBA system. Connect a regulated high-pressure oxygen source capable of continuously providing compressed air at 90 liters/min. at a pressure of 2000 psig to the oxygen input port of the SCUBA system. Connect a similar helium source to the helium input port of the SCUBA system.

b. Perform procedures described in paragraph 6.2.14.2.1c. (If a self-mixing helium-oxygen system is under test, use appropriate fittings to couple an oxygen sensing device to the inhalation port of the mechanical breather. The sensor should indicate percentage oxygen in gas entering input port of breather).

c. Using appropriate fittings, couple a carbon dioxide sensing device to the inhalation port of the mechanical breather. The sensor should indicate percentage of carbon dioxide in gas entering input port of breather. With the SCUBA system connected to the proper high-pressure gas sources (described in step a.) and with the carbon dioxide absorbent canister properly filled with fresh carbon dioxide absorbent materials, mount the SCUBA mouthpiece or face mask on the mechanical breather head. Place the head and SCUBA system in a tank of water ensuring that the water surface is at least two inches above the absorbent canister. Activate the SCUBA and compressed gas source (2000 psig.) Set the mechanical breather for a respiratory rate of 10 breaths/min., an air-flow rate of 30 liters/min., and a carbon dioxide exhalation rate of 1.25 liters/min. Ambient temperature shall be maintained at 95°F. Measure and record percentage carbon dioxide in inhaled breathing media for three-hour period or until carbon dioxide sensing device indicates greater than 0.5 percent.

d. Repeat test described in step c. with ambient temperature first at 61°F and then 27°F.

e. Repeat tests described in step c. and d. with carbon dioxide exhalation flow rate increased first to 1.6 liters/min. and then to 2.0 liters/min. The duration of each test shall be one hour. Renew the carbon dioxide absorbent material prior to starting each test.

6.2.15.2.3 Simulated Diving Test

a. Assemble and adjust SCUBA system for normal operation. (Unless otherwise specified, compressed gas cylinders shall be pressurized to 3000 psi.) If a closed SCUBA system is under test, use appropriate fittings to couple a carbon dioxide and, if a self-mixing oxygen-helium system is under test, an oxygen sensing device to the inhalation port of the mechanical breather.

The sensors should each indicate percentage of the respective gas in breathing media entering input port of breather. Mount SCUBA mouthpiece or face mask on dummy head of mechanical breather. Place SCUBA system and dummy head in a tank of water in a decompression chamber with no portion of the SCUBA system less than two inches below surface of water.

b. Activate mechanical breather and SCUBA systems. Adjust mechanical breather for an air-flow rate of 40 liters/min., breathing rate of 20 breaths/min., and a carbon dioxide exhalation rate of 1.6 liters/min. Set ambient temperature of 61°F. Record inhalation and exhalation pressure, flow resistance, flow rate, and if applicable, percentage of oxygen and carbon dioxide in inhaled media as a function of decompression chamber pressure as the pressure is increased from 15 to 105 psia in five psia increments. Pressure should be increased to 105 psia in minimum time while still allowing sufficient time for the system to stabilize before recording measurements after each change in pressure. Continue recording measurements taken at 105 psia in five-minute intervals until a definite change in measurement values is noted, then, record measurements in one-minute intervals until the gas cylinders are exhausted.

6.2.15.2.4 SCUBA Turnaround Time

a. Obtain two divers fully dressed for a diving mission minus SCUBA gear. One diver shall be dressed in a wet suit and one in a dry suit.

b. Measure and record time and difficulty for the two divers, assisting each other as necessary, to don SCUBA gear and prepare for entry into the water. Note and record if type suit worn is a factor in this time period.

c. Measure and record time and difficulty for the two divers, assisting each other as necessary, to replace compressed gas cylinders in SCUBA gear with fresh cylinders and prepare for entry into the water.

6.2.16 Simulated Environment Tests

6.2.16.1 Extreme Low Temperature Test (-65°F, -53.9°C)

This test is used to determine the effect of SCUBA storage at extreme low temperatures.

a. Disassemble, preserve and crate the SCUBA system according to instructions supplied in draft technical manual for low temperature storage.

b. Place the prepared SCUBA system in a low temperature test chamber.

c. Set and maintain the chamber temperature at -65°F (-53.9°C) for a period of 72 hours.

d. Raise the chamber temperature from -65°F to 61°F and maintain temperature at 61°F for a 24-hour period.

e. Remove SCUBA system from chamber; uncreate, depreserve and visually inspect SCUBA components. Record evidence of component fracture or cracking, loss of flexibility and softness of rubber components, and any other indication of SCUBA failure to withstand extreme low temperature storage.

f. Complete SCUBA evaluation performance procedures described in paragraph 6.2.15.

6.2.16.2 Extreme High Temperature Test (155°F, 68.3°C)

This test is used to determine the effect of SCUBA storage at extreme high temperatures.

a. Disassemble, preserve and crate the SCUBA system according to instructions supplied in draft technical manual for high temperature storage.

b. Place the prepared SCUBA system in a high temperature test chamber.

c. Set and maintain the chamber temperature at 155°F for a minimum period of four hours.

d. Cool the SCUBA system to 61° and remove system from chamber; uncrate, depreserve and visually inspect SCUBA components. Record evidence of component fracture or cracking, loss of flexibility and softness of rubber components, and any other indication of SCUBA failure to withstand extreme high temperature storage.

e. Complete SCUBA performance evaluation procedures described in paragraph 6.2.15.

6.2.16.3 Fungus Test

a. Perform test method 508 of MIL-STD-810 on SCUBA system and record all results.

b. Complete pertinent SCUBA performance evaluation procedures described in paragraph 6.2.15.

6.2.16.4 Salt Fog Test

a. Perform test method 509, procedure I, of MIL-STD-810 on SCUBA system and record all results.

b. Complete SCUBA performance evaluation procedures described in paragraph 6.2.15.

6.2.16.5 Sunshine Test

a. Perform test method 505, procedure I, of MIL-STD-810 on SCUBA system and record all results.

b. Complete SCUBA performance evaluation procedure described in paragraph 6.2.15.

6.2.17 Electromagnetic Interference

The magnetic field intensity of the SCUBA system shall be determined in accordance with MIL-M-19595. Unless otherwise specified, maximum value of field intensity so obtained should not exceed 0.05 millioersteds.

6.2.18 Durability

a. Perform the applicable sections of MTP 10-2-502.

b. Operate the SCUBA system at one atmosphere pressure, 61°F ambient air temperature, for 1000 hours continuous operation. The mechanical breathing apparatus shall be used for this period to simulate actual usage of the SCUBA system in the following manner:

1) On the SCUBA system under test, replace compressed air, oxygen, and/or helium, tanks with respective high pressure, regulated sources capable of continuously providing compressed gas at 45 liters/min. at a pressure of 2000 psig.
2) Place the SCUBA, compressed gas, and mechanical breather systems in an environment test chamber set at one atmosphere pressure and an ambient air temperature of 61°F. On fixed gas mixture systems (either open or closed), mount the SCUBA system mouthpiece or face mask on the dummy head of the mechanical breather. On automatic, oxygen-helium regulating, closed SCUBA systems, use appropriate fittings and couple an oxygen sensing device to the inhalation port of the mechanical breather before the SCUBA face mask or mouthpiece is mounted on the dummy head.
3) Activate the mechanical breather, SCUBA system and compressed gas system. Set and maintain the mechanical breather at a respiratory rate of 30 breaths/min. and a flow rate of 45 liters/min. Measure and record, at five-hour intervals for a total period of 1000 hours, inhalation and exhalation pressure, flow resistance, and, if an automatic oxygen-helium regulating system is under test, percentage of oxygen in gas mixture applied to mechanical breather input port.

6.2.19 Transportability

Perform the applicable portions of MTP 10-2-503 and record all results.

NOTE: The draft technical manual shall be reviewed or consulted for proper procedures for tying down, lifting, and transporting the test item by various media. Any inadequacy of instructions should be reported by EPR.

6.2.20 Maintenance Evaluation

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

a. Organizational, Direct Support (F), and General Support (H) Maintenance requirements.

b. Operator through General Support Maintenance literature, if applicable.

c. Repair parts.

d. Calibration and maintenance facilities.

e. Test and handling equipment.

f. Maintenance facilities.

g. Personnel skill requirements.

h. Maintainability.

i. Availability.

6.2.21 Reliability

Evaluate and appraise the reliability related factors of the test item as described in MTP 10-2-512.

6.2.22 Safety

This test evaluates the safety characteristics and features of the test item.

WARNING: Improper use of SCUBA gear or use of gear improperly handled, stored, or charged is extremely hazardous to life. Before using a SCUBA system, obtain supervised training in the use of that system including

instructions on proper response to any possible emergency that might occur during an intended diving mission. Also, ensure strict compliance with the following points:

1) Follow general safety rules governing the use of compressed gas cylinders and gases described in TM 55-375, paragraph 1.7.7.
2) Ensure that only approved gas pressure pumps are used to fill compressed gas cylinders and that proper provisions are made to keep oil vapors from contaminating the compressed gas. (Ensure that filter mechanisms used to eliminate oil-vapor contamination of gas are properly installed, aligned, and functioning.)
3) Never charge a cylinder with gases other than that for which it is designated to carry; never use a SCUBA system with compressed gases other than that for which it was designed; never pressurize a compressed gas cylinder above its normal operating pressure limits (as stamped on its walls); never store a cylinder pressurized to less than 15 psig.
4) Before using a SCUBA system in a diving mission ensure that the compressed gas tanks and carbon dioxide absorbent canister, if used, are properly filled, and complete the following checks:

    a) Inspect system for indication of wear, rot or loss of rubber component flexibility, and any other visual indication of impending system failure.
    b) Assemble SCUBA system; activate system and check for air leaks by submerging system in a tank of water.
    c) Don SCUBA system and check operation by inhaling and exhaling through the regulator.
    d) Enter water and again check proper operation of SCUBA system when just below surface by inhaling and exhaling through the regulator and hoses.

5) Follow all instructions provided in draft technical manual for maintenance of SCUBA system.

NOTES:
1. At the completion of the test, issue a safety statement in accordance with USATECOM Regulation 385-6.
2. During the conduct of all tests, test personnel shall observe the proper safety precautions and in particular, shall adhere closely to the manufacturer's instructions for the handling and use of the test item.

3. The procedures for all tests and the test item shall be examined and any condition which might constitute a safety hazard shall be recorded and also reported to the testing officer.

Perform the following:

a. Prepare a list of all safety devices used with the test item. For each safety device listed, simulate the type of condition for which the device provides safeguard. Record the following data for each safety device:

1) The device/feature tested.
2) Failure which the device is to detect.
3) Operation of the safety device.

b. Examine the test item for the following:

1) Adequacy of the design capabilities of SCUBA divers' belt and cylinder harness for quick release in case of emergency.
2) Any dangerous or unsafe conditions resulting from inadequacies of SCUBA design or features. Record steps taken to alleviate any such hazard.
3) Adequacy of warning instructions and markings on SCUBA system.

c. Record any suggestions to improve existing safety features of SCUBA system.

6.2.23 Human Factors Evaluation

The test item shall be evaluated to determine the degree to which test item physical design and revealed performance characteristics conform to recognized human factors engineering design criteria. In order to facilitate this evaluation, prepare checklists of design criteria applicable to Class IV D material as defined by Human Factors Evaluation Data for General Equipment (HEDGE). Also, incorporate applicable procedures of MTP 10-2-505 and the following:

a. General considerations to be included in checklists for all tests:

1) Adequacy of furnished instructions.
2) Ease of performing tasks.
3) Human factors design deficiency revealed by particular test.
4) Time to perform task.
5) Personnel required for task.

b. Area considerations to be included in checklists for all tests:

1) Fit and adjustment items.
2) Ease of controlling and adjusting test item as worn.

c. Include in the technical performance checklists revealed performance characteristics which did not conform to recognized human factors design criteria.

d. Subjective evaluation checklist to be completed by various test subjects and qualified observers.

1) Odor (objectionable or not).
2) Facial fit.
3) Comfort of item over long period (two hours).
4) Restrictions on visibility of face mask.
5) Don/doff suitability.

e. Record any inadequacies of test item design affecting ease of use.

f. Record any recommendations to improve man-item effectiveness.

6.2.24 Value Analysis

Throughout all tests, the test item shall be examined for any unnecessary, costly, "nice-to-have" features as described in USATECOM Regulation 700-1. Perform the following:

a. During operation of the test item, observe for features which could be eliminated without compromising performance, reliability, durability, or safety.

b. Question test personnel regarding features of the test item which could be eliminated without decreasing the functional value of the test item or decrease man-item effectiveness.

c. Record the following:

1) Nonfunctional, costly, or "nice-to-have" features of the test item.
2) Test personnel comments and opinions regarding features to be eliminated.

6.2.25 Quality Assurance

Throughout all tests, examine the SCUBA equipment for compliance with the quality requirements of the applicable MN and the provisions of MTP 10-2-511.

6.3 TEST DATA

NOTE: In compiling the Test Data section, test personnel should expound upon those data procedures which are other than quantitative in nature by recording narrative descriptions which will provide full details of conditions and/or events occurring during the conduct of the test.

6.3.1 Preparation for Test

6.3.1.1 Initial Inspection

6.3.1.1.1 Shipping and Packaging Inspection

Record the following:

a. Any noncompliance with the standards for shipping, marking, preservation and packaging.

b. Evidence of damage; identification markings and test of printed matter enclosed.

c. Equipment, time, and personnel required to unpack and assemble the test item. Comments concerning the method and materials used in packing, clarity or assemblage instructions, and ease of assemblage.

6.3.1.1.2 Test Item Inspection

6.3.1.1.2.1 General

Record the following:

a. Any instances of noncompliance with the marking requirements of MIL-STD-130.

b. Evidence of defects in the manufacturing, materials and workmanship; improperly painted or rust protected surfaces.

c. Instances of contact by dissimilar metals.

d. Occurrence of nonstandard connectors.

e. Occurrence of missing components, support equipment, or draft technical manual.

f. Indication of incorrectly assembled or aligned components.

g. Indication of broken, rough or malformed components.

h. For each compressed gas cylinder, volume (cubic feet), maximum working pressure (psi), date of last inspection, visual condition, and instances of noncompliance with MIL-T-704.

i. Instance of noncompliance of diving belt with stated requirements.

j. Instances of noncompliance of knife assembly with stated requirements.

k. Instances of noncompliance of depth gauge with requirements for the US Navy Standard Gage, Depth, Wrist: MK1; 1844080 Rev A; lack of adjustable dial or indicator.

l. Instances of noncompliance of watch with stated requirements.

m. Instances of noncompliance of face mask with stated requirements, and any indication of improper fit of face mask.

n. Instances of noncompliance of wrist compass with stated requirements.

o. Instance of noncompliance of swim fins, fin shoes, and snorkel with stated requirements.

p. Instance of noncompliance of wet and dry suits with stated requirements.

q. Instance of noncompliance of slate and pencil with stated requirements.

r. Instance of noncompliance of camera and camera equipment with stated requirements.

s. Instance of noncompliance of electric lantern with stated requirements.

6.3.1.1.2.2 Open Circuit SCUBA

Record instances of the following occurrences:

a. Compressed air tanks of volume less than 72.4 cubic feet.

b. Manifold lacks single on-off control valve, two 3900 psig blow-out discs, and a manual air-reserve mechanism.

c. Regulator not demand type, two-stage, or does not have a pressure indicator positioned to be visible to diver while diver wears equipment.

d. Tank harness not nylon or improperly designed for quick divestment of SCUBA.

e. Improperly designed or fabricated mouthpiece; check-valves not functioning properly.

f. Hoses not constructed of nonkinking, flexible corrugated or bellows type rubber or neoprene material. Hoses not rated safe to 250 psi and have at least one swivel type connector.

g. Inadequate, missing or malfunctioning filters, caps, or other required auxiliary hardware.

h. Improperly located or pressure compensated exhaust valve.

6.3.1.1.2.3 Closed Circuit SCUBA

Record instances of the following occurrences:

a. Inproperly sized compressed air tanks.

b. Improperly sized, fabricated or designed breathing bag.

c. Carbon dioxide canister improperly sized, fabricated, baffled or water sealed; lack of four to five psig pressure relief valve.

d. Improperly designed, installed and aligned oxygen measuring and metering device. Accuracy of device not in agreement with requirements of SDR or technical characteristics.

e. Manifold lacks single on-off control valve, two 3900 psig blow-out discs and a manual air-reserve mechanism.

f. Regulator not demand type, two stage, or does not have a pressure indicator positioned to be visible to diver while diver wears equipment.

g. Tank harness not nylon or improperly designed for quick divestment of SCUBA.

h. Improperly designed or fabricated mouthpiece; check-valves not functioning properly.

i. Hoses not constructed of nonkinking, flexible, corrugated or bellows type rubber or neopreme material. Hoses not rated safe to 250 psi and have at least one swivel type connector.

j. Manual bypass valve not provided with automatic oxygen metering mechanism.

6.3.1.2 Inventory Check

List any materials missing from the Basic Issue Item List.

6.3.1.3 Physical Characteristics

Record the data required by MTP 10-2-500.

6.3.1.4 Operator Training and Familiarization

Record the data required by MTP 10-2-501 and the following:

a. Methods used and completion of test personnel training and evaluation of the technical manuals.

b. Evidence that the test personnel are sufficiently knowledgeable in objectives and procedures.

c. Personal data required for each selected personnel as follows:

1) MOS
2) Rank
3) Unit
4) Amount of experience of MOS.
5) Amount of training in MOS.

6.3.1.5 Preoperational Checks

Record the following:

a. Depreservation procedures utilized. Time required and difficulty in charging gas cylinders and making SCUBA system operational.

b. Any malfunctioning or incorrectly installed and aligned components.

c. Any missing or ineffectual components.

6.3.2 Test Conduct

6.3.2.1 Compressed Gas Cylinder

Record the following:

a. Hydrostatic test pressure applied to cylinder.

b. Expansion of cylinder when pressure applied.

c. Permanent expansion of cylinder.

6.3.2.2 Knife Test

Record the following:

a. Knife blade length.

b. Bouyancy of knife (positive or negative).

c. Describe the work ability and resistance to dulling exhibited by the knife as a function of work period.

d. Angle at which blade breaks.

e. Ability of knife to resist salt-fog corrosion effects.

6.3.2.3 Watch Test

Record the following:

a. Accuracy of watch prior to completing hydrostatic and salt-fog tests. (Accuracy is expressed in number of seconds lost or gained in a 24-hour period.)

b. Accuracy of watch after completing hydrostatic and salt-fog tests.

c. Ability of watch to resist salt-fog corrosion effects.

6.3.2.4 Compass Test

Record the following:

a. Accuracy (degrees) and settling time (seconds) of compass prior to completing hydrostatic and salt-fog test.

b. Fluctuations of North indicator as a function of water pressure.

c. Accuracy and settling time of compass after completing hydrostatic salt-fog test.

d. Ability of compass to resist salt-fog corrosion effects.

6.3.2.5 Face Mask Test

6.3.2.5.1 Safety Glass Transmissibility

Calculate and record average of T_1, T_2, T_3, and T_4 for the five test cycles described in paragraph 6.2.5.1.

6.3.2.5.2 Safety Glass Shatter Resistance

Record weight and drop height of impact ball versus damage to safety glass. Record any instance where safety glass shattered upon impact of ball.

6.3.2.6 Electric Lantern Test

Record the following:

a. Luminous intensity (foot-candles) of lantern prior to hydrostatic test.

b. Malfunctions or decrease of luminous intensity of lantern following hydrostatic or salt-fog tests; steps taken to correct faulty condition.

c. Decay of lantern power supply (evidenced by decreasing luminous intensity of lantern) as a function of time.

d. Ability of lantern to resist salt-fog corrosion effects.

6.3.2.7 Pencil and Slate Test

Record ability/inability of writing and erasing information on slate immersed in water.

6.3.2.8 Depth Gauge Test

For each test dive, record sea level of water surface and depth marker versus gauge indications. Record also, ability of depth gauge to resist slat-fog corrosion effects.

6.3.2.9 Camera Test

Record the following:

a. Applicable data required by MTP 10-2-132 with camera shutter speed varied from 1/30 to 1/500 of a second, lens opening varied from f2.5 to f16, and film speed varied from ASA 25 to 2000.

b. Mount depth marker pictures on a suitable display board such that the quality of each picture can be compared to the remaining pictures. Note and record any degradation of picture quality with diving depth. Record a qualitative statement on camera's ability to take pictures in diving depth of 0 to 200 feet. Record also, any visual deterioration of the camera's surface and mechanisms resulting from the diving and picture taking mission.

6.3.2.10 Wet and Dry Suit Tests

6.3.2.10.1 Dry Suit Leakage

Record locations of leaks, if any.

6.3.2.10.2 Hydrostatic Pressure Resistance of Coated Fabric Seams (Dry Suit)

Record the following:

a. Pressure at which leaking occurs, if any.

b. Location of leaks, if applicable.

6.3.2.10.3 Sizing and Fitting

Record the following:

a. Any difficulty in adjusting size and fit of test item to body dimensions of diver.

b. Insufficient or inadequate adjustments on test item.

c. Any difficulty or hinderance offered by test item in completing routine diving missions.

6.3.2.10.4 Donning and Doffing

Record the following:

a. Any difficulty in donning and doffing test item; assistance required.

b. Subjective opinions of divers regarding the ease and safety of donning and doffing the test item with respect to the following, if applicable:

1) Suitability of fastenings 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.

6.3.2.10.5 Insulation Test

Record the following for both the wet and dry suits:

a. Skin temperature monitoring points.

b. Temperature of water in test tank.

c. Skin temperature at each monitoring point taken in one minute intervals over the 30-minute test period.

6.3.2.10.6 Tear Resistance Test

Record the following for both the wet and dry suits:

a. Before aging the suit:

1) Die used to cut specimen (A, B, or C, method 4211 of FED-STD-601).
2) Force (F) in pounds required to tear specimen.
3) Thickness (T) of the specimen in inches.

b. Record data required in step a. after aging the suit.

6.3.2.11 Life Preserver Test

Record deviations of life preserver characteristics with those required by MIL-L-16383; record data obtained in completing procedures in MTP 10-1-195.

6.3.2.12 Storage Container Test

Record the following:

a. Inability to sink empty container without use of external weighting material.

b. Evidence of moisture penetrating watertight storage compartment when tested at atmospheric pressure or 103 psia.

6.3.2.13 Spear Gun Test

Record the following:

a. Type of underwater targets used; test visibility conditions.

b. Ability of spear gun to drive spears into selected targets at ranges of 5, 10, 15 and 20 feet. Accuracy of spear gun at each range.

c. Increased depth of spear penetration into targets at each range due to power heads.

6.3.2.14 Pressure Guage Test

a. Tabulate test item and performance standard indications of each test measurement made.

b. Underline or make a second tabulation of any deviations between performance standard and test item indications that exceed accuracy tolerance specified in the SDR, TC or other development criteria.

c. Record a subjective evaluation of ability of gauge to resist salt-fog corrosion effects.

6.3.2.15 SCUBA Tests

6.3.2.15.1 Component Performance Tests

6.3.2.15.1.1 Air Hose Burst Test

Record bursting strength of each hose or ability of hose to withstand 1000 psig.

6.3.2.15.1.2 One-way Check Valves

Record the following:

a. Ability of valve to seat and retain one-half psig.

b. Ability of valve to seat and retain three psig.

6.3.2.15.1.3 Manifold Assembly

Record the following:

a. Ability of shut-off valve to completely restrain air flow with 3900 $\pm$ 390 psig pressure applied to valve.

b. Blow-out discs (one or both) release at 3900 $\pm$ 390 psig.

6.3.2.15.1.4 Low Pressure Safety Relief Test

Record the following:

a. Pressure at which low-pressure safety release operates.

b. Pressure at which low-pressure safety release closes.

c. Ability of safety release to completely restrain air flow with air pressure set midway between opening and closing pressures.

6.3.2.15.1.5 Hose and Regulator Group Leakage Test

Record the following:

a. Failure of manometer to maintain specified water level.

b. Emission of bubbles from pressurized hose and regulator group.

6.3.2.15.1.6 Regulator Hydrostatic Test

Record any evidence of inability of high pressure regulator to withstand 5000 psig hydrostatic pressure.

6.3.2.15.1.7 Pressure Relief Valve Test (carbon dioxide absorbent canister)

Record the following:

a. Pressure at which relief valve operates.

b. Pressure at which relief valve closes.

c. Ability of relief valve to completely restrain air flow with air pressure set midway between opening and closing pressures.

6.3.2.15.2 System Performance Tests

6.3.2.15.2.1 Open System Mechanical Breathing Test

Record the following:

a. Indication of air leaks when SCUBA system operated in tank of water.

b. Possible interference of diver's vision by discharged air bubbles.

c. Using the constant high pressure air source, record inhalation and exhalation pressure and flow resistance as a function of air flow rate at 95°F, 61°F, and 27°F with mechanical breather set first to 30 breaths/min. and then to 10 breaths/min.

d. Using the compressed gas cylinders, record inhalation and exhalation pressure and air flow resistance as a function of decreasing cylinder pressure (50 psig increments). Record also, ambient temperature, air flow rate, and number breaths/min. used during test.

e. Pressure at which air flow is stopped by reserve mechanism.

f. Operation of air reserve mechanism and data required in step d. as cylinder pressure decays toward zero psig.

6.3.2.15.2.2 Closed System Mechanical Breathing Test

Record the following:

a. Type of system under test (fixed gas or self-mixing system).

b. Data required in paragraph 6.3.2.15.2.1. In addition, if a self-mixing system is used, percentage oxygen in gas entering input port of breather should also be recorded with data required in the referenced steps.

c. Percentage carbon dioxide in inhaled breathing media (10-minute intervals) as a function of carbon dioxide exhalation rate at 95°F, 61°F, and 27°F.

6.3.2.15.2.3 Simulated Diving Test

Record the following:

a. Type of system under test (open, closed, and if closed, fixed or self-mixing gas system).

b. Inhalation and exhalation pressure, flow resistance, and if applicable, percentage of oxygen and carbon dioxide in inhaled media as a function of decompression chamber pressure from 15 to 105 psia in increments of five psia.

c. Inhalation and exhalation pressure, flow resistance, and if applicable, percentage of oxygen and carbon dioxide in inhaled media in five-minute intervals, then one-minute intervals as compressed gas cylinder(s) becomes exhausted. Decompression chamber pressure is maintained at 105 psia during recording of this data.

6.3.2.15.2.4 SCUBA Turnaround Time

Record the following:

a. Time and difficulty to don SCUBA gear and prepare for entry into the water. (If noticeably different for each diver, record data as a function of type suit worn.)

b. Time and difficulty to replace compressed gas cylinders with fresh cylinders and prepare for entry into the water. (If noticeably different for each diver, record data as a function of type suit worn.)

6.3.2.16 Simulated Environment Tests

6.3.2.16.1 Extreme Low Temperature Test (-65°F, -53.9°C)

Record the following:

a. Evidence of SCUBA system deterioration such as component fracture or cracking, loss of flexibility and softness of rubber components, open seals, broken glass, etc., resulting from low temperature storage.

b. Record, as applicable, performance data required in paragraph 6.3.2.15. Compare data with that obtained prior to performing storage test; record any deviations of data.

6.3.2.16.2 Extreme High Temperature Test (155°F, 68.3°C)

Record the following:

a. Evidence of SCUBA system deterioration such as component fracture or cracking, loss of flexibility and softness of rubber components, open seals, broken glass, etc., resulting from high temperature storage.

b. Record, as applicable, performance data required in Paragraph 6.3.2.15. Compare data with that obtained prior to performing storage test; record any deviations of data.

6.3.2.16.3 Fungus Test

Record the following:

a. Evidence of SCUBA system deterioration such as loss of flexibility and softness of rubber components, inoperable valves, deterioration of fabrics, etc., resulting from fungus test.

b. Record, as applicable, performance data required in paragraph 6.3.2.15. Compare data with that obtained prior to performing test; record any deviations of data.

6.3.2.16.4 Salt-Fog Test

Record the following:

a. Evidence of SCUBA system deterioration such as corrosion of metallic components, inoperative valves, loss of flexibility and softness of rubber components, etc., resulting from salt-fog test.

b. Record, as applicable, performance data required in paragraph 6.3.2.15. Compare data with that obtained prior to performing test; record any deviations of data.

6.3.2.16.5 Sunshine Test

Record the following:

a. Evidence of SCUBA system deterioration such as loss of flexibility and softness of rubber components, deterioration of fabrics, etc., resulting from sunshine test.

b. Record, as applicable, performance data required in paragraph 6.3.2.15. Compare data with that obtained prior to performing test; record any deviations of data.

6.3.2.17 Electromagnetic Interference

Record value of magnetic field intensity of SCUBA system in millioersteds.

6.3.2.18 Durability

Record the data required by MTP 10-2-502 and the following:

a. In five-hour intervals for a total period of 1000 hours, respiratory rate, air-flow rate, inhalation and exhalation pressure, flow resistance, and, if an automatic oxygen-helium regulating system is under test, percentage of oxygen in gas mixture applied to mechanical breather input port.

b. In a SCUBA malfunction occurs such as a marked deviation or cessation of measurements taken while completing step a., record the following, then, complete step a.

1) Nature of malfunction.
2) Number of hours after endurance test began that malfunction occurred.
3) Total operating life (hours) of malfunctioning component.
4) Procedures used to repair malfunction.
5) Time and difficulty in repairing malfunction.
6) Availability and standardization of repair parts.
7) Adequacy of maintenance instructions for correcting malfunction.

c. If applicable, prepare a list of malfunctions and a brief description of each malfunction.

6.3.2.19 Transportability

Record the following:

a. Data required by applicable procedures of MTP 10-2-503.

b. Description of damage visually noted following transportability test.

c. Evidence of inferior or changed test item performance attributable to transportability test.

6.3.2.20 Maintenance Evaluation

Record data required by applicable procedures of MTP 10-2-507 and Appendixes A and B to USATECOM Regulation 750-15.

6.3.2.21 Reliability

Record data required by applicable procedures of MTP 10-2-512.

6.3.2.22 Safety

a. Prepare a table to include the following:

1) A list of all safety devices and features used on the test item.
2) The type of failure that each device is to safeguard.
3) Indication that the device has successfully operated.

b. Record the following:

1) Adequacy of warning instructions and markings.
2) Any missing devices or unsafe conditions.
3) Any suggested additions to the test item's safety features.

6.3.2.23 Human Factors Evaluation

Record the following:

a. Data required by applicable procedures of MTP 10-2-505.

b. Checklists (complete according to HEDGE criteria).

c. Noted inadequacies of test item design affecting ease of test item operation.

d. Recommendations to improve man-item effectiveness.

6.3.2.24 Value Analysis

Record the following:

a. Non-functional, costly, or "nice-to-have" features of test item.

b. Test personnel comments and opinions regarding features which could be eliminated in accordance with criteria of USATECOM Regulation 700-1.

6.3.2.25 Quality Assurance

Record:

a. Data required by MTP 10-2-511.

b. Comments as to any design shortcomings in the area of required quality.

6.4 DATA REDUCTION AND PRESENTATION

6.4.1 Data Reduction

6.4.1.1 Watch Test

Calculate percent degradation of performance resulting from hydrostatic and salt-fog tests using the following formula:

$$D = \frac{|Ai| - |Af|}{Ai} \times 100$$

where D = percent degradation of performance.

$|Ai|$* = Accuracy initial

$|Af|$* = Accuracy final

* $|\ |$ denotes absolute (or positive) value of enclosed quantity.

For example, $|-2| = |2| = 2$.

6.4.1.2 Compass Test

Calculate percent degradation of performance resulting from hydrostatic and salt-fog tests using the following formula:

$$D = \frac{|Ai| - |Af|}{|Ai|} \times 100$$

where D = percent degradation of performance

$|Ai|$* = Accuracy initial

$|Af|$* = Accuracy final

* $|\ |$ denotes absolute (or positive) value of enclosed quantity.

For example, $|-2| = |2| = 2$.

6.4.1.3 Face Mask Test

Safety Glass Transmissibility

Using the average values of T_1, T_2, T_3, and T_4 recorded in paragraph 6.3.2.5.1, calculate total luminous transmittance (T_T) and diffuse luminous transmittance (T_d) using the following formulas:

$$T_T = \frac{T_1 - T_2}{T_1}$$

$$T_d = \frac{T_4 - T_3 (T_T)}{T_1}$$

6.4.1.4 Wet and Dry Suit Tear Resistance Test

Compute the degradation of the wet and dry suit tear resistance due to aging by using the following formula:

$$D = \frac{Ti - Tf}{Ti} \times 100$$

where D = percent degradation of tear resistance.

Ti = tear resistance initial.

Tf = tear resistance final.

6.4.2 Data Presentation

Tabulate and summarize the remaining data as appropriate. All data should be compared with the technical performance characteristics specified in the MN or other development criteria. In addition, the report should include a written statement as to the suitability of the test item for service test.

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13. ABSTRACT

Procedures are prescribed for determining the operational suitability of open and closed SCUBA systems, including diving accessories.

DD FORM 1 NOV 68 1473 REPLACES DD FORM 1473, 1 JAN 64, WHICH IS OBSOLETE FOR ARMY USE.

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