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EVALUATION OF SEATEC "MILITARY MANTA" BUOYANCY COMPENSATOR

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19. ABSTRACT: **NEDU was tasked to conduct a survey of commercially available buoyancy compensators (BC's), and perform testing to determine which BC perform satisfactorily. Buoyancy compensator evaluation was conducted in three phases. Phase I, receipt inspection of the buoyancy compensator, technical review of the manufacturer supplied documentation (instructions / repair manuals), diver orientation, and Test Pool Evaluation (BC surface floating attitudes if used as a Life Jacket). No failure mode analysis was conducted. Phase II consisted of buoyancy / lift capacity testing in the Test Pool at 15 fsw. Phase III consisted of manned dives in the Gulf of Mexico to test diver buoyancy control and operational characteristics.**

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INTRODUCTION

Navy Experimental Diving Unit (NEDU) is tasked[1] to conduct surveys of commercially available buoyancy compensators (BCs), and perform testing to determine which BCs perform satisfactorily in accordance with references (2) and (3). All BCs that meet the above requirements will be candidates for recommendation to the Authorized for Navy Use (ANU) list. The purpose of this technical report is to determine if SEATEC "Military Manta" buoyancy compensator meets those requirements.

METHODS

GENERAL

Each BC was tested and evaluated in three different environments Phase I (Bench Test), Phase II (Controlled Environment (Test Pool/Ocean Simulation Facility (OSF)), and Phase III (Open Ocean Diving). While bench testing, each BC was evaluated by two qualified U.S. Navy divers for completeness and adequacy of maintenance manuals and technical documentation, skill level required to perform routine repair and maintenance, operation of the integrated weight belt and the operation of all BC components. In a controlled environment, each BC was tested and evaluated for buoyancy and lift capability. While performing open water dives, each BC was used and evaluated by qualified U.S. Navy divers in both single and double SCUBA tank configurations to a minimum of 30 fsw (9.4 msw). The conversion for msw is in accordance with reference (4).

EXPERIMENTAL DESIGN AND ANALYSIS

All BCs tested were off the shelf items; three sizes were tested, (i.e., medium, large and X-large). The Task Leader or assigned representative was present during the set-up and post-dive procedures on all BCs.

Phase I testing:

- Each model BC was evaluated by two qualified U.S. Navy divers for ease of operation and maintenance procedures.
- Average cost, from five different suppliers was acquired.

Specific comments from evaluators were compiled and documented.

Phase II testing:

- Each different size BC were tested to 15 fsw (4.7 msw) utilizing the Test Pool. Each BC was fully inflated in both single and twin configurations, recording the average lift capacity.

Phase III testing:

- Each different size BC were evaluated during open water dives. A series of evaluation dives per BC, per tank configuration is conducted (i.e., single, twin). All open water dives were conducted to a minimum depth of 30 fsw. Divers completed a human factor questionnaire after each dive. A set of descriptive statistics of the responses and specific comments were complied.

EQUIPMENT AND INSTRUMENTATION

No special or proprietary tools were required to perform routine maintenance or repair on the BCs.

a. Phase I: During bench testing, the following equipment was used:
   (1) Fully charged SCUBA bottle and an approved regulator (used to supply low-pressure air to perform equipment checks)
   (2) Manufacturer's instructions and maintenance manual
   (3) Miscellaneous hand tools and adapter fittings
   (4) Weights (soft or molded)

b. Phase II: During Test Pool testing the following equipment was used:
   (1) Calibrated Viking spring scale model 895, 0 to 50 pounds (0 to 22.68 kg) manufactured by Hanson in Shubuta, Mississippi.
   (2) Lanyards, spinnaker shackles, and weight as appropriate to anchor BCs to deck in wet chamber
   (3) Fully charged SCUBA bottle and an approved regulator (used to supply low-pressure air)
   (4) Personnel as required
   (5) Weights

c. Phase III: During at sea testing, the following equipment was used:
   (1) Fully charged SCUBA bottle, approved regulator and all other personnel diving equipment needed to perform a SCUBA dive
   (2) Personnel as required
   (3) At sea diving platform

PROCEDURES

BC evaluation was conducted in three phases: (1) receipt inspection and technical review of manufacturer supplied documentation, (2) Test Pool evaluation (buoyancy/lift capacity at 15 fsw), (3) open water dives to test buoyancy control and operational characteristics.

a. Phase I testing began with a review of the following:
   (1) Completeness and adequacy of the maintenance manuals and technical documentation
   (2) Requirements for special or proprietary tools
   (3) Skill level required to perform routine repair and maintenance

(4) Operation of integrated weight system
(5) Operation and activation of all BC components
(6) Ease of assembly from single tank configuration to twin tank configuration
(7) Unit price

A technical documentation and operational function worksheet was completed by each qualified diver assigned, and returned to the Task Leader.

b. Phase II Testing: Buoyancy/lift capacity of the units were tested in the Test Pool at a depth of 15 fsw. All divers participating in the study were required to familiarize themselves with the contents of the user's manual, to include location of controls on the BC and donning procedures.

A calibrated Viking spring scale model 895 was attached to the deck grating of the OSF to measure buoyancy. Each BC tested was attached to the scale and tested in the Test Pool at 15 fsw. The buoyancy was measured and documented; at a minimum, each BC was required to provide 10 lbs. of positive lift as outlined in reference (2). The BC was also tested for leaks at depth.

c. Phase III Testing: Manned open water dives were conducted to a minimum depth of 30 fsw to determine each BC's swim characteristics. Results were documented using a diver's questionnaire.

RESULTS

PHASE I

The inspection of the manufacturer's supplied documentation on the use, service, parts, technical aspects and exploded views/diagrams was adequate. Documentation fails to include a parts list or technical specifications within the supplied buoyancy compensator manual, but are available from the manufacturer upon request. There were no requirements for special or proprietary tools needed. Skill level required to perform routine maintenance should be at least a second class diver or above. The integrated weight system weights were secure and easy to operate the release mechanism. The operation and activation of all BC components were easy to operate. There were no problems assembling the single tank configuration to the twin tank configuration.

The "Military Manta" BC has two 38 gram CO^2 cartridges located under the left and right pockets. The CO^2 cartridge mechanisms were tested an operated to verify operation and ensure the actuator pins would not bend, brake or jam. All BCs were tested four times each with no failures noted.

The average manufacturer's suggested price per unit (X-Small –Large) is $263.50, and $274.50 (X-Large).

PHASE II

The "Military Manta" BC in the single tank configuration averaged 30 lbf (Medium), 33.5 lbf (Large), 39.5 lbf (X-Large) of positive lift at 15 fsw (4.7 msw) (see Table 1). The measured buoyancy of the "Military Manta" BC was approximately 20% more than the 25 lbf (Medium), 11.5% more than 30 lbf (Large) and 1.5% less than the 40 lbf (X-Large) quoted by the manufacturer. However, that difference might have been due to differing test conditions, procedures, or depth.

In the twin tank configuration, the "Military Manta" BC averaged 30 lbf (Medium), 31.5 lbf (Large), 38.5 lbf (X-Large) of positive lift at 15 fsw (4.7 msw) (see Table 2). The measured buoyancy of the "Military Manta" BC was approximately 20% more than the 25 lbf (Medium), 5% more than 30 lbf (Large) and 3.5% less than the 40 lbf (X-Large) quoted by the manufacturer. Again the difference might have been due to differing test conditions, procedures, or depth.

PHASE III

During the manned evaluation of the "Military Manta" BC, 11 divers tested the BC in single tank configuration and seven divers tested the BC in double tank configuration to depths ranging from 30 fsw to130 fsw (40.6 msw). On a scale of 1 – 6 (4.0 being the minimum mark for an overall acceptable score), this BC scored a rating of 5.33 in the single tank configuration and 4.98 in the twin tank configuration.

CONCLUSIONS

While testing this BC, the only item of concern encountered through diver's comments and operation was that 40% of the divers felt that the BC would squeeze them or that it fit very snug when fully inflated.

RECOMMENDATIONS

Based on the testing and evaluation in accordance with reference (3) and reported in Tables (1) and (2), we recommend that the SEATEC Model name "Military Manta" BC (P/N: Medium 1001-3126, Large 1001-5126, and X-Large 1001-6126) be authorized for continued Navy use. No surface floating attitude testing was conducted as per manufacturer's supplied documentation, therefore we do not recommend this buoyancy compensator be used as a life preserver.

Table 1. Seatec "Military Manta" Buoyancy Compensator Pull Test Data in Single and Twin Tank Configuration

Seatec "Military Manta" Single Tank Configuration					
NO.	NOMENCLATURE	BC #	PULL TEST WEIGHT (LBF)	DEPTH	INFLATION METHOD
1	Seatec "Military Manta"	M	30 LBF	15 FSW	LP WHIP FROM SCUBA BOTTLE
2	Seatec "Military Manta"	L	33.5 LBF	15 FSW	LP WHIP FROM SCUBA BOTTLE
3	Seatec "Military Manta"	XL	39.5 LBF	15 FSW	LP WHIP FROM SCUBA BOTTLE
Seatec "Military Manta" Double Tank Configuration					
NO.	NOMENCLATURE	BC #	PULL TEST WEIGHT (LBF)	DEPTH	INFLATION METHOD
1	Seatec "Military Manta"	M	30 LBF	15 FSW	LP WHIP FROM SCUBA BOTTLE
2	Seatec "Military Manta"	LG	31.5 LBF	15 FSW	LP WHIP FROM SCUBA BOTTLE
3	Seatec "Military Manta"	XL	38.5 LBF	15 FSW	LP WHIP FROM SCUBA BOTTLE

Table 1. Each size BC was tested to 15 fsw (4.7 msw) utilizing the Test Pool. Each BC was fully inflated three times in both single and twin configurations. Recording the average lift capacity.

Table 2. Human Factors Evaluation of the Seatec "Military Manta" Buoyancy Compensator in Single Tank and Twin Tank Configuration

Seatec "Military Manta" Single Tank Configurtion

	#8	#9	#10	#11	#12	#13	#14	#15	#16	
QUESTIONNAIRE #	COMFORT	MOBILITY	DONNING & DOFFING	NEUTRAL BUOYANCY	LOCATION OF CONTROLS	OPERATING CONTROLS	WATER DRAG	COMFORTABLE DIVING	OVERALL RATING	AVERAGE
1	6	6	6	6	5	5	5	5	5	5.44
2	6	6	6	6	6	6	6	6	6	6.00
3	5	5	5	5	4	3	4	5	5	4.56
4	4	4	5	4	4	4	4	4	4	4.11
5	6	6	6	5	5	6	6	6	6	5.78
6	6	6	6	6	6	6	6	5	6	5.89
7	5	5	5	5	5	5	4	5	5	4.89
8	5	5	5	5	5	5	4	5	4	4.78
9	5	6	6	5	5	5	5	6	5	5.33
10	6	6	6	6	6	6	6	6	6	6.00
11	6	6	6	6	6	6	6	6	5	5.89
QUESTION AVERAGE	5.45	5.55	5.64	5.36	5.18	5.18	5.09	5.36	5.18	5.33
								OVERALL AVERAGE		5.33

Seatec "Military Manta" Twin Tank Configurtion

	#8	#9	#10	#11	#12	#13	#14	#15	#16	
QUESTIONNAIRE #	COMFORT	MOBILITY	DONNING & DOFFING	NEUTRAL BUOYANCY	LOCATION OF CONTROLS	OPERATING CONTROLS	WATER DRAG	COMFORTABLE DIVING	OVERALL RATING	AVERAGE
1	4	5	5	4	4	4	5	4	4	4.33
2	3	4	5	5	4	4	3	2	4	3.78
3	5	5	5	5	5	5	5	5	5	5.00
4	5	5	5	5	6	5	5	5	5	5.11
5	6	6	6	5	6	5	6	6	6	5.78
6	6	6	6	6	6	2	6	5	6	5.44
7	6	5	5	5	6	5	5	6	6	5.44
QUESTION AVERAGE	5.00	5.14	5.29	5.00	5.29	4.29	5.00	4.71	5.14	4.98
								OVERALL AVERAGE		4.98

Table 2. A series of evaluation dives will consist of ten man dives per BC, per tank configuration. All open water dives were conducted at a minimum depth of 30 fsw (9.4 msw). Divers completed a human factors questionaire after each dive. A set of descriptive statistics of the responses and specific comments were complied. The BCs is scored on a scale of 1 – 7 scale (4.0 being the minimum mark for an overall acceptable score) (1 = poor, 4 = adequate, 7 = excellent).

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1. Commander, Naval Sea Systems Command, Task Assignment 98-10, *Commercial Diving Equipment Test and Evaluation*, Dec 97.
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