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FITNESS STANDARDS FOR DIVING

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FITNESS STANDARDS FOR DIVING*

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INTRODUCTION

Commercial diving is a hazardous profession because of the environment in which the individual is forced to work. In this environment he must cope with the stresses of hypothermia, blackwater, fast currents and increased pressure. In addition, the equipment worn by the divers makes it very awkward to perform even the simplest task. Once on the job the diver is alone and must rely on his own capacities to meet all the demands of the task and this environment. The diving community is at present just starting to investigate the minimum fitness requirements for divers. This report is a collaborative study between DCIEM and Seneca College of Applied Arts& Technology which addresses the problem of measuring the energy demands of diving and establishing minimum fitness standards for operational diving at the college.

METHOD

Students from five successive classes from 1976 to 1981, from Seneca College's Underwater Skills Program were used as subjects for this report. All were healthy males between the ages of 17 and 28 years.

Work tasks representative of commercial diving were taken from the Seneca College Underwater Skills course syllabus. The majority of these tasks were performed in a lake used by Seneca for underwater training. The oxygen costs of these activities were estimated from heart rate responses measured by telemetry during task performance. The heart rates were substituted into previously developed oxygen cost equations derived for these subjects (Bell & Wright, 1979).

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Two components of physical fitness relevant to the diver, aerobic power and grip strength, were measured on two successive classes in the exercise physiology laboratory at DCIEM. The fitness parameters were measured at the beginning, middle and end of their course. Grip strength was measured using a hand dynamometer and aerobic power was predicted from work performed on a bicycle ergometer (Astrand & Rhyming, 1954).

Minimum Fitness Standard

The oxygen costs of the tasks are shown in Table 1.

Table 1
Heart Rate and Oxygen Cost of Underwater Work Tasks*

	Heart Rate (b/min)	Oxygen Cost (l/min)
Leg Tasks		
Familiarization dive	108	1.04
50 Foot dive	116	1.24
Tending	118	1.27
Drilling	127	1.50
Jetting	130	1.57
Chipping	131	1.58
Water entry	134	1.67
Water exit	145	1.93
Progressing on bottom	150	2.05
Arm Tasks		
Burning & Welding	105	1.05
Seneca pipe puzzle	106	1.07
Pipeline Construction	115	1.20
Mechanical flange	116	1.22
Gate valve	116	1.22
DCIEM pipe puzzle	121	1.33
Drill, rig, saw	151	1.76

* From Bell & Wright, Ergonomics 22(3): 345-356, 1979.

Getting to and from the work site by trudging through the mud appears to be the most strenuous activity a diver performs. Once there the most demanding tasks were hand sawing and drilling. The hand sawing and drilling tasks required 1.76 litres of oxygen uptake and formed the basis from which the minimum cardiorespiratory fitness level for diving was established. Good ergonomic practice suggests that the most demanding task use only half the aerobic capacity of an individual (Astrand & Rodahl, 1970). The minimum

fitness level for the aerobic power was thus established as twice the most demanding work site task or 3.5 $l.min^{-1}$.

Aerobic Power

The aerobic power of the initial two classes was more than the 3.5 $l.min^{-1}$ recommended above when they started the program, but by graduation had declined, Figure 1.

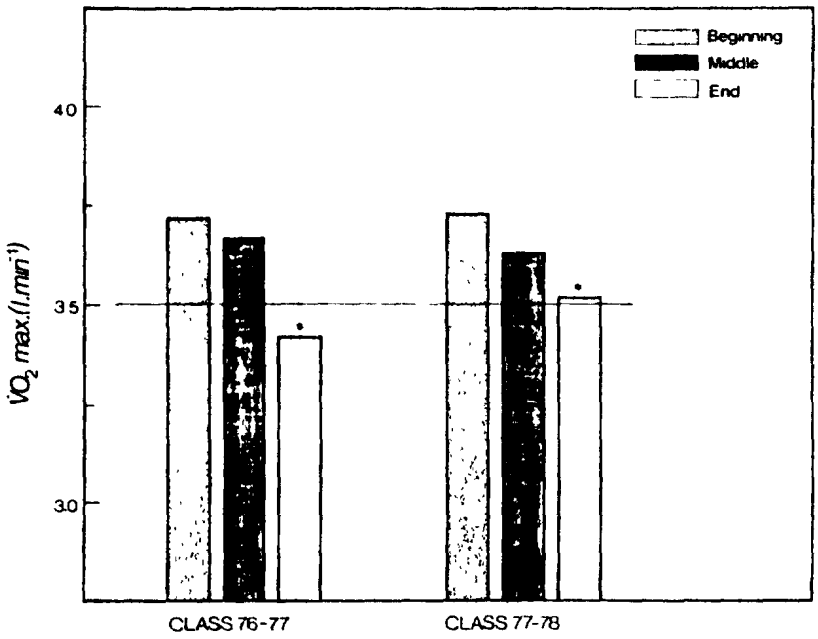

Figure 1: Aerobic Power of Initial Two Classes
*Significantly different from initial values.

This decrease in aerobic power can be explained by the nature of diving activities. In the majority of the cases the tasks although performed for a sufficient duration, 45 minutes, and frequency, 3 to 4 times per week, are not of sufficient intensity, 43% of divers' capacity, to promote or maintain aerobic power.

After reviewing these results the College implemented conditioning programs designed specifically to enhance the aerobic fitness component. This program included 10-15 minutes of warmup activities (stretching, calisthenics, pushups and situps), and 20-30 minutes of jogging or swimming. The effect of this conditioning program was evaluated for the next three years (Figure 2). When conditioning was compulsory during the first year, class of 79/80, the standard was exceeded. When the conditioning was left to the individual, class of 79/80, the standard was not met. As a result of the 79/80 experience, participation in conditioning was again made mandatory. The results of the 80/81 class show significant improvement.

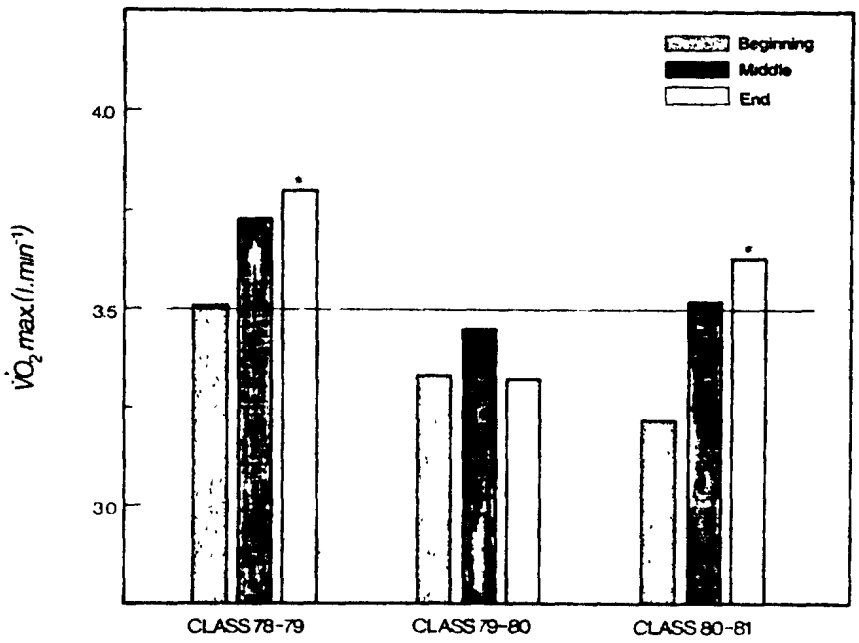

Figure 2: Aerobic Power of Subsequent Classes
*Significantly different from initial values.

Strength

Previous studies have shown that arm work constitutes a significant proportion of the divers job (Bell & Wright, 1979; Weltman et al., 1969). Arm work performed both in the water and on the surface may account for the increase in grip strength depicted in Figure 3.

In the water the diver generally worked at 57% of his arm work capacity for 45 minutes per day, 3 to 4 times per week. Surface activities demanded that he move heavy diving equipment from one work site to another in preparation for the next series of dives. This suggests that diving activities when performed regularly will promote the increases in strength needed for their profession, and that strength programs are not required for diving.

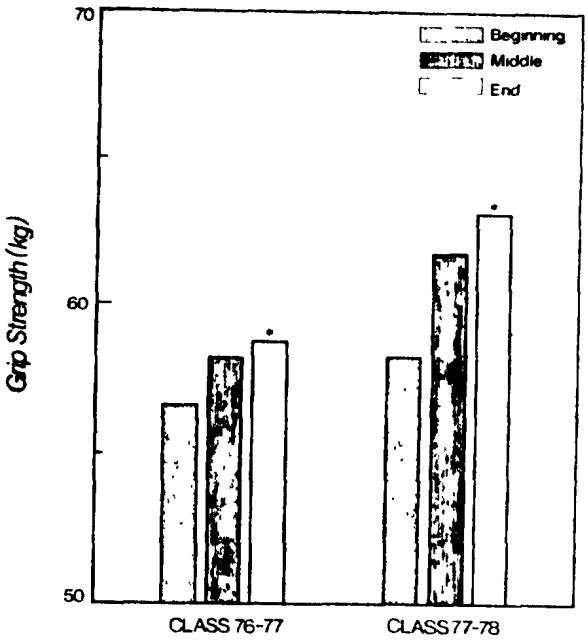

Figure 3: Grip Strength of Initial Two Classes
* Significantly different from initial values.

CONCLUSION

The minimum cardiorespiratory fitness level needed for performing commercial diving activities is 3.5 $l.min^{-1}$ oxygen uptake.

The physical demands of mmercial diving alone will not maintain the aerobic power at the level of 5 $l.min^{-1}$. A program specifically designed to increase this component of fi ess is required.

By contrast diving activities performed regularly are of sufficient intensity to promote increases i arm strength commensurate with the profession.

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