

LIFE JACKET SPRAY-HOOD FUNCTION AND IMPROVEMENTS

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INTRODUCTION

Spray hoods are additional items of lifejackets. They are effective in reducing water entry into airways when victims of maritime accidents are immersed in rough seas. Since the introduction of this equipment into practical use, many have ignored its advantages. The arguments against it are as follows: (1) "I can't see anything under this equipment because of condensing water from inside," (2) "The water presses the hood onto mouth and nose and so I can't breathe" (3) "The air exchange rate under the hood is not high enough, so I will be intoxicated by CO₂ and die due [to] lack of oxygen." Despite these arguments, we added spray hoods as additional items to the European Standard dealing with lifejackets and also to an ISO proposal dealing with personal floatation devices, safety requirements and test methods. The aim of our study was to verify that spray hoods improve the chance of survival and do not endanger victims.

METHODS

Trials were conducted with test subjects in the North Sea (with the assistance of the German Association of Life Savers [DGzRS]) and in a Navy pool to assess whether the spray hood impairs (1) vision due to condensation of water inside the spray hood and (2) breathing due to the spray hood obstructing the airways. Flooding of the breathing openings in the spray hood was evaluated using a seaworthy manikin (RAM) in a Navy pool. The manikin was suited with appropriate protective clothing and with different types of lifejackets. Flooding time and frequency was registered by an opto-electronic sensor incorporated in the manikin and connected to a laptop computer. All our trials were made with inflatable lifejackets of 150 to 250 N buoyancy. The gas exchange under the spray hood was measured in calm air with humans and the manikin under dry conditions in the lab and repeated under wet conditions in a pool. The measurement equipment was an oxygen measurement device (Pac II 02, DRAEGER Company) connected with an interface to the computer. All measurements were made at a distance of 5 to 10 cm from the person's breathing openings. To determine the rates of gas exchange, we used a double chamber lifejacket, equipped with a spray hood with 4 ventilation openings, each 5 cm in diameter. Within seconds after activating the second chamber of the lifejacket, we obtained 17 liters of CO₂ under the spray hood via the overpressure valve. In all persons, we measured blood oxygen concentration and heart rate. Gas exchange under the spray hood was determined by measurement of oxygen concentration rather than

carbon dioxide, since a decrease in O_2 concentration will be reflected in a proportionate rise in CO_2 concentration.

In addition, measurements of O_2 concentration under the spray hood were conducted during normal breathing with no additional injections of CO_2 . During these trials, subjects were floating in calm water with minimal air movement. The life jacket was inflated and the spray hood positioned appropriately.

RESULTS AND DISCUSSION

The problem of reduced vision due to condensation was not evaluated in the present study. In cold weather conditions, condensation is inevitable, and trials to evaluate this problem seemed unnecessary. In rough weather conditions, high speed spray will reduce vision significantly to a greater degree than condensation inside the hood. Thus, without the spray hood, it is not possible to see anything in such conditions.

The trials revealed that under some circumstances, the hood may be pressed onto the face by the water and may hinder breathing. This appears to be related to the design of the life jacket and spray hood. Namely, very loose and/or large spray hoods increase the risk of the hood pressing on the face. This problem will not occur if the life jacket and spray hood are properly designed. Large life jackets, which are normally worn in heavy weather over heavy duty protective clothing, may also cause pressing of the spray hood on the face under some circumstances. Recently, a new spray hood was introduced that appears to address this problem (1). The design incorporates woven fabric elements, which stiffen the cap once the water pressure pushes the hood down. This equipment was evaluated with a manikin during field trials in collaboration with our search and rescue ships and in the Navy wave pool.

Our trials dealing with flooding reduction showed that there occurs a significant reduction of water contact using spray hoods. Flooding frequency and flooding time in rough sea conditions are both reduced, except with very poorly designed life jackets with low freeboard or poor shape. In some cases the flooding time was reduced to 10% of that without such a feature (see Figure 1).

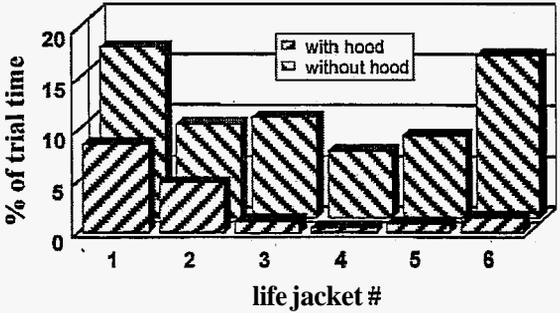


Figure 1. Effect of Spray Hoods on life jacket flooding

The rate of gas exchange into the hood was determined by injecting a large amount of CO_2 into it, while the life jacket was activated with the hood in use. An injection of 17 liters of CO_2 under the spray hood caused a rapid reduction in the O_2 concentration. The lowest registered level was 7.17%. There were some differences between life jackets depending on the opening speed of the overpressure valve, and there were some differences between wet and dry use, and differences between manikin and human use. The first experiments on men under dry conditions showed a reduction to 11.3% oxygen with one to 14.2% with the other life jacket. The time below 15% oxygen was 12 and 5 seconds. These findings are depicted in Figure 2.

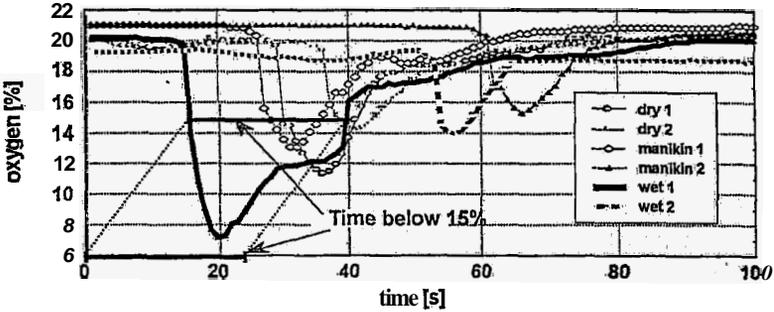


Figure 2. Oxygen exchange level under spray hood

Under the same conditions with the manikin, the same life jackets showed a reduction to 13 and 15.3%. The time below 15% occurred only with the first life jacket. The trials were repeated in water with humans, and here the values went down to 7.2% with one jacket and 13.9% with the other jacket. The time below 15%, which was set as danger limit, was 24 s with the first and 5 s with the other life jacket (see Figure 3). Our safety limit was chosen with 15% as done in our life raft paper (2).

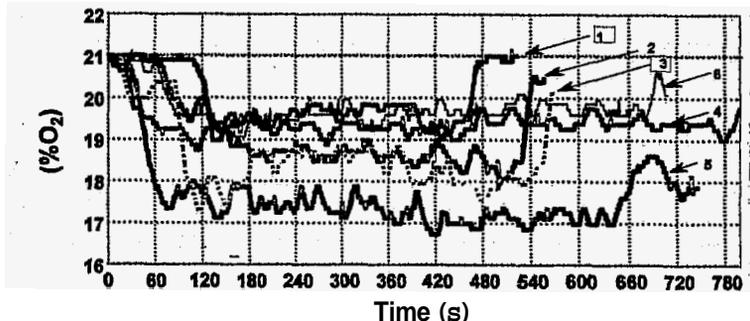


Figure 3. Oxygen concentrations for 6 different spray hoods.

Under normal conditions, when at least 4 openings with a diameter of approximately 5 cm or more are enabled, the gas exchange is adequate and prevents excessive accumulation of CO₂ under the spray hood. The gas exchange becomes impaired in water because water blocks several exchange routes, resulting in elevation of % CO₂ under the spray hood.

Under conditions of no air movement (worst condition) and normal breathing, the % O₂ remained above 17%. Most hoods were capable of maintaining % O₂ above 19% (see Figure 2). The differences between the hoods are due to differences in design. In poorly designed equipment, the buoyancy components of life jackets may occlude the spray hood vents once they are inflated.

Some manufacturers redesigned the form and/or position of the vents in the spray hood, based on our recommendations. Subsequent evaluation of the redesigned hoods demonstrated that the redesign improved the gas exchange characteristics of the hood. In one example, the % O₂ in the spray hood was improved from 17% to 19% (see Figure 4).

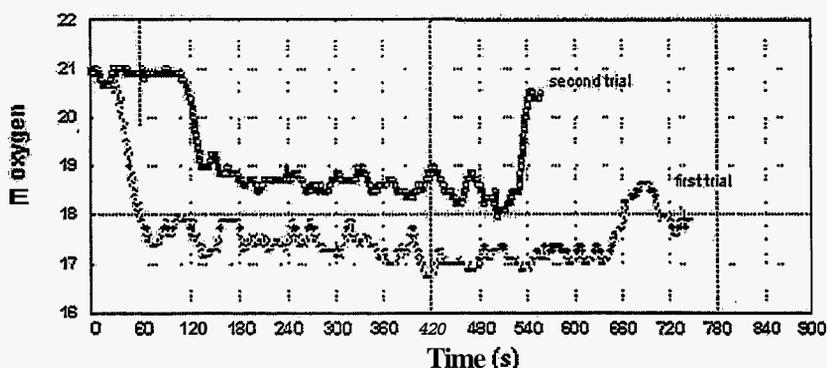


Figure 4. Effect of design changes.

CONCLUSIONS

The results of our study support the recommendation that spray hoods be fitted to every lifejacket, especially where the likelihood of immersion in rough seas is great. Properly designed spray hoods do not pose a health risk to the wearer and improve the chances of survival.

REFERENCES

1. Herrmann, R. 1996, Rettungswesten—Untersuchung einer neuentwicklung (Life Jackets—Research work and a new development), *Hansa* 133, 5, 27-28.
2. Herrmann, R.A. 1997 Low liferafts—sufficient oxygen inside for survival?, *Travel Medicine International*, 15, 52-55.