THE IMPACT OF IMMERSION SUIT USE ON LIFEBOAT CAPACITIES

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Abstract
At the 2003 meeting of the International Marine Organization (I.M.O.) a report was presented
indicating that wearing an immersion suit may reduce the capacity of lifeboats. Following the
meeting a study was conducted to quantify the affects of wearing suits on human
anthropometry of seafarers in Atlantic Canada. Mean body masses of 88 and 89 Kg were
recorded in two independent samples. These are significantly greater than the IMO standard
of 75 kg. The suits significantly increased all breadth dimensions and the shoulder breadths
values were always greater than hip breadth. The mean physical size of the seafarers
without suits, are greater than the values currently used in the IMO standard. The current use
of hip breadth measurement for space allocation in the IMO standard should be reviewed and
replaced by shoulder breadth. Based upon these results the current lifeboat loading capacity
should be downgraded by at least 15%.

Key Words: Structural Anthropometric Dimensions, Ship Abandonment Suits, Workspace

LES RÉPERCUSSIONS ENTRAÎNÉES PAR LES COMBINAISONS D’IMMERSION SUR
LA CAPACITÉ DE CHARGE DES CANOTS DE SAUVETAGE

Résumé
Lors de la réunion de l’Organisation maritime internationale (OMI) tenue en 2003, un rapport
a été présenté en soulignant que le port d’une combinaison d’immersion pouvait réduire la
capacité de charge des canots de sauvetage. Après cette réunion, une étude a été réalisée
afin de quantifier les incidences du port d’une combinaison sur l’anthropométrie des gens de
mer au Canada atlantique. Les masses corporelles moyennes de 88 et 89 kg ont été
consignées lors de deux échantillons indépendants. Ces données sont beaucoup plus
élevées que la norme de l’OMI de 75 kg. Les combinaisons augmentaient considérablement
toutes les valeurs taille-largeur et les valeurs taille-épaule étaient toujours plus élevées que
les valeurs taille-hanche. La taille physique moyenne des gens de mer sans le port d’une
combinaison est donc plus élevée que les valeurs actuellement utilisées dans les normes de
l’OMI. La valeur d’usage taille-hanche pour l’attribution de l’espace, stipulée dans la norme
de l’OMI, devrait faire l’objet d’une révision afin de la remplacer par la valeur taille-épaule. En
se basant sur les résultats obtenus, la capacité de charge actuelle des canots de sauvetage
devrait être réduite d’au moins 15%.

Mots clés : mesures anthropométriques structurelles, combinaison en cas d’abandon du
navire, espace de travail.
INTRODUCTION

There is a mandatory requirement for commercial marine operators to carry immersion suits in case of abandonment either into a lifeboat, life raft, or directly into the water. Offshore workers in Canada also wear immersion suits during helicopter transport to and from the offshore platform or rig and for abandonment in the event of a rig disaster (Brooks, 1986; Gaul, & Mekjavic, 1987). In the event that the worker is immersed in cold water as the result of a marine accident, or while abandoning the platform or rig, the primary function of the suit is flotation and protection against cold shock, swimming failure, hypothermia and post-rescue collapse (Brooks, 1986; Leese, & Norman, 1979). The suit should not hinder or degrade the ability of the user to enter, strap in securely, unstrap, and exit the lifeboat. The individual must not only be protected from the environment, but he or she must be able to perform the necessary functional tasks associated with the emergency. At the 2003 meeting of the International Marine Organization (I.M.O.) a report was presented indicating that wearing an immersion suit may reduce the capacity of lifeboats. Following the meeting a two-part study was conducted to: (1) quantify the affects of wearing suits on human anthropometry and space allocation, and (2) determine the number of seafarers who could fit into a lifeboat. The focus of this paper is on the first question.

METHODS

This study was conducted in two separate labs one located in Dartmouth, NS and the second in St John’s, NFLD using offshore workers as the test subjects. The research teams met once prior to any testing to standardize the instrumentation and measurement methodologies. Stature, body mass, hip and shoulder breadths from a sample of 87 seafarers in Dartmouth, Nova Scotia (80 males and 7 females) and 80 seafarers in St. John’s, Newfoundland were recorded. In Dartmouth four different conditions: normal work clothing, and in each of three different ship abandonment suits (Helly-Hansen, Fitzwright and Mustang) were tested. In St. John’s, only one suit (Mustang) was used. Measurements were made under two conditions a standard method for anthropometry and with compression to simulate a “packed” seating accommodation. Standard descriptive and inferential statistics were performed on the data for comparative purposes.

RESULTS AND DISCUSSION

Table 1 provides a description of age, physical dimensions and marine / offshore experience of the 87 subjects (males and females combined) tested in Dartmouth. The age ranged from 18 to 58 years, mass ranged from 46.8 to 145.5 kg, height ranged from 1563 to 1913mm, BMI ranged from 17.9 to 45.7, and offshore work experience ranged from 0 to 34 years. Similar values were found for the subjects measured in St. John’s.

| Table 1: Descriptive statistics for the Dartmouth study. (n=87) |
|-----------------|-------|--------|------|-------|------|
| Age (yr)        | 37.1  | 9.8    | 36.0 | 18.0  | 58.0 |
| Experience (yr) | 6.4   | 8.1    | 3.0  | 0.0   | 34.0 |
| Mass (Kg)       | 86.3  | 15.5   | 85.5 | 46.8  | 145.5|
| Height (mm)     | 1748  | 71.7   | 1750 | 1563  | 1913 |
| BMI (Kg/m²)     | 28.2  | 4.4    | 28.1 | 17.9  | 45.7 |
Shown in Table 2 are the shoulder and hip breadth measures with and without compression for the work clothes and three different suits. The mean shoulder breadth measures ranged from 515 to 604 mm uncompressed and 441 to 472 mm compressed. The seated hip breadths were all greater than the standing measures and not surprisingly, the compressed values were all less than the uncompressed.

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Condition</th>
<th>Work clothes</th>
<th>Helly - Hansen</th>
<th>Fitzwright</th>
<th>Mustang</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean  SD</td>
<td>Mean  SD</td>
<td>Mean  SD</td>
<td>Mean  SD</td>
</tr>
<tr>
<td>Shoulder breadth</td>
<td>Normal</td>
<td>515  38</td>
<td>592  38</td>
<td>595  31</td>
<td>604  38</td>
</tr>
<tr>
<td></td>
<td>Comp.</td>
<td>441  35</td>
<td>458  33</td>
<td>468  39</td>
<td>472  36</td>
</tr>
<tr>
<td>Hip breadth standing</td>
<td>Normal</td>
<td>383  26</td>
<td>424  27</td>
<td>425  29</td>
<td>427  31</td>
</tr>
<tr>
<td></td>
<td>Comp.</td>
<td>322  23</td>
<td>327  23</td>
<td>335  26</td>
<td>330  23</td>
</tr>
<tr>
<td>Hip breadth seated</td>
<td>Normal</td>
<td>419  29</td>
<td>464  25</td>
<td>459  29</td>
<td>452  23</td>
</tr>
<tr>
<td></td>
<td>Comp.</td>
<td>357  28</td>
<td>376  30</td>
<td>380  29</td>
<td>377  29</td>
</tr>
</tbody>
</table>

The statistical analysis showed that there were significant main effects of suits and condition (compression and no compression) and a significant interaction of suits by conditions. The shoulder breadth, hip breadth standing and hip breadth seated dimensions recorded in the work clothes were significantly smaller than the same dimensions for any the suit conditions (F=361.5, df 3,603, p<0.001). With the compression all three anthropometric dimension values were significantly less than the uncompressed measures (F=6633.5, df 1,603, p<0.001). An equally important finding was the significant suit by compression interaction effect that highlights two important points. Compression had a significantly greater change in the suited measures than the work clothes measure and compression had significantly less of an effect on the Fitzwright suit than the other two suits (F=99.6, df 3,603, p<0.001).

Comparing the Newfoundland and Nova Scotia data

A series of t-Tests were conducted to compare the recorded measures between the two locations. There were no significant differences in the mean age (37.1 vs. 37.7 yrs), experience (6.4 vs. 5.4), mass (86.3 vs. 88.4 Kg), height (1748 vs. 1751 mm) and BMI (28.2 vs. 28.6 Kg/m²) values between the two samples. There were significant differences in the two hip breadth measures between the two samples. In both cases the data from Newfoundland were less than the hip breadths measures of the samples in Nova Scotia by 15 and 33 mm for the standing and seated measures, respectively. This may be due to a measurement standardization difference or a true difference in the samples.

CONCLUSION

The purpose of this study was to determine the affects of wearing a survival suit on workspace allocation in a lifeboat. According to IMO standards the mean weight of a seafarer is 74 Kg and the linear space allowance (buttock width) is 430 mm. Based upon this anthropometric survey of a total of 167 Atlantic seafarers, the following conclusions are justified.
The observations made at the IMO meeting are correct. The wearing of an immersion suit will require an increase in space allocation; however, this is only part and parcel due to the addition of the immersion suit.

Body mass is an important measure to determine the load capacity of the lifeboat but is not a good indicator for space allocation. The current value of 75 Kg used by the IMO is inadequate for the North American population. The mean mass measured in this study was 86 Kg, an increase of approximately 15% over the current value.

The value of 430 mm for space allocation is also too low and does not represent the actual space requirement. For proper space allowance the 95\textsuperscript{th} percentile shoulder breadth value of 575mm should be used. The use of value will significantly reduce the rated capacity of lifeboats by approximately 33%.

It is recommended that IMO request one European country and one in the Far East to conduct a similar measuring exercise on its population. With this completed and considering the information found in this study a proper upward adjustment must be made to the weight and space allocations.

**RELEVANCE TO INDUSTRY**

Based upon the current information the marine industry must downgrade their current lifeboat capacities and more importantly should revise the standard dimensions used to in the IMO LSC to better reflect the seafarer population.

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**REFERENCES**

