# Effectiveness of the air mask fit for bearded airline pilots

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## INTRODUCTION

There is a widespread belief that facial hair reduces the effective seal of airline pilots' oxygen masks, thereby decreasing protection from hypoxia during emergencies like rapid decompression. Many airlines argue that beards prevent pilots from safely controlling the aircraft and have instituted policies banning them. The FAA leaves this up to individual airlines while also claiming mask effectiveness could be impaired by facial hair.

Figure 1. Example of >10mm beard fit of the *Sweep-On 2000 crew oxygen mask system*

Figure 2. Example of <10mm beard fit for the *Sweep-On 2000 crew oxygen mask system*

## OBJECTIVES

This study aimed to analyze the effectiveness of the *Sweep-On 2000 crew oxygen mask system* (Fig 3), standard for airline pilots, at maintaining bearded and non-bearded users SpO2 levels when exposed to high altitudes.

Figure 3. The *Sweep-On 2000 crew oxygen mask system.*

## METHODOLOGY

A group of commercial pilots funded a study at the High Altitude Lab (HAL) in the College of Aviation to assess the effectiveness of standard airline masks during simulated exposure to 30,000 ft altitude. The participants, pilots and students, were divided into three groups; long beards (≥10 mm), short beards (<10 mm), and clean-shaven (Figs 1,2). There were 13 persons in the long beards, 9 in the short beards and 9 in the clean shaven groups.

Participants were briefed on HAL safety and completed the required training to enter the chamber. Beard lengths were measured, and participants were then assigned a numbered seat. Oximeters recorded oxygen saturation and heart rate data every 2 seconds.

Participants spent approximately ten minutes with the air mask donned and then the mask was removed to expose them to hypoxic conditions. Once the mask was placed back on, the participants were exposed to smelling salts to further test the effectiveness of the seal.

## RESULTS

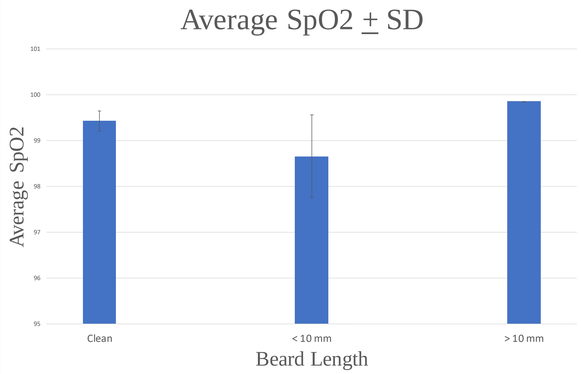


Figure 4. Bar graph with standard deviation of the three beard categories comparing their average SpO2 while wearing the mask.

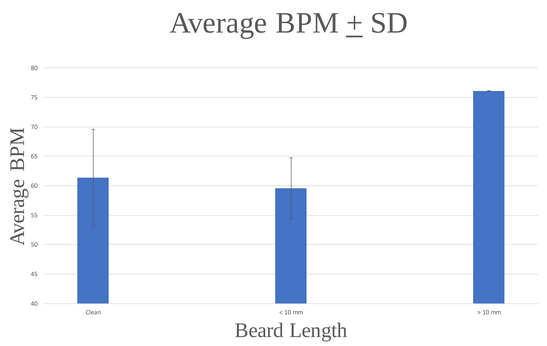


Figure 5. Bar graph with standard deviation of the three beard categories comparing their average heart rate in BPM while wearing the mask.

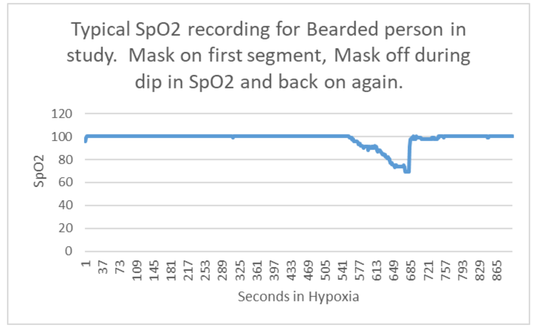


Figure 6. Typical SpO2 data showing 10 minutes in hypoxia with mask on, then mask off., then mask on.

## DISCUSSION

With masks on for 10 minutes at around an altitude of 30,000ft, no leaks were evident from the oximeter readings (Figure 6). Average SpO2 stayed within normal limits for all participants, when wearing the mask, regardless of beard length (Figure 4). Average BPM also stayed within normal limits for all participants, when wearing the mask, regardless of beard length (Figure 5).

Masks were then removed for approximately 3 minutes to confirm the oximeters could detect hypoxia levels. After quickly re-donning the masks for another 10 minutes, and no leaks were detected. Ammonium salts waved underneath the masks could not be smelled, demonstrating the masks' seals were tight enough to prevent chemical exposure.

## CONCLUSIONS

The study found no evidence that facial hair caused mask leaks, hypoxia, or chemicals to affect performance.

## REFERENCES

Desteiguer, D., Hudson, K. E., U.S. Department of Transportation, Federal Aviation Administration, Goldberg, M., Higgins, E. A., Lyne, P. J., Saldivar, J. T., Griffin, O. G., Longson, D. J., Hyatt, E. C., Pritchard, J. A., Richards, C. P., Geoffrion, L. A., Naber, D. G., Warncke, L., Schipke, W., Busby, D. E., Funkhouse, G. E., & Desteiguer, D. (1987). *THE INFLUENCE OF BEARDS ON OXYGEN MASK EFFICIENCY*. https://www.faa.gov/documentLibrary/media/Advisory_Circular/AC120-43.pdf

Floyd, E. L., Henry, J. B., & Johnson, D. L. (2017). Influence of facial hair length, coarseness, and areal density on seal leakage of a tight-fitting half-face respirator. *Journal of Occupational and Environmental Hygiene*, *15*(4), 334–340. https://doi.org/10.1080/15459624.2017.1416388

*High-Altitude Normobaric Chamber | Embry-Riddle Aeronautical University - Daytona Beach, FL*. (n.d.). https://daytonabeach.erau.edu/about/labs/high-altitude-normobaric-chamber

*Sweep-On® 2000TM Crew Oxygen Mask*. (n.d.). Collins Aerospace. https://www.collinsaerospace.com/what-we-do/industries/commercial-aviation/cabin/oxygen-and-psu-systems/crew-oxygen-systems/crew-masks/sweep-on-2000