U.S. Department of Transportation
Federal Aviation Administration

Advisory Circular

Subject: THE INFLUENCE OF BEARDS ON OXYGEN MASK EFFICIENCY

Date: 1/27/87 **AC No:** 120-43
Initiated by: AFS-220 **Change:**

1. PURPOSE. This advisory circular provides information about the effects of beards on masks in continuous flow and demand oxygen systems.

2. RELATED FEDERAL AVIATION REGULATIONS (FAR) AND TECHNICAL STANDARD ORDERS (TSO). FAR Sections 91.32, 121.327, 121.329, 121.331, 121.333, 121.337, and 135.157; TSO's C78 and C89.

3. RELATED READING MATERIAL.

a. The Civil Aeromedical Institute (CAMI) research is basically contained in the following two reports which are available from CAMI's Protection and Survival Laboratory, Mike Monroney Aeronautical Center, Oklahoma City, Oklahoma 73125.

(1) The Influence of Beards on the Efficiency of Aviator's Oxygen Masks, D. deSteiguer and K. E. Hudson. Prepared for presentation at the Survival and Flight Equipment Symposium, December 2-6, 1979, Hotel Sahara, Las Vegas, Nevada.

(2) The Effect of Beards on the Efficiency of Continuous-Flow Passenger Masks, E. A. Higgins, P. J. Lyne, and J. T. Saldivar. Memorandum No. AAM-119-85-2.

b. Additional information on this subject may be found in the following documents available from the National Technical Information Service, Springfield, Virginia 22161.

(1) Individual Respiratory Protection Against C and B Agents, Goldberg, M. et. al., Report No. 84DDEL, Edgewood Arsenal, 1966.

(2) Influence of Facemask Design on Operator Performance, Second Conference on Portable Life Support Systems, Griffin, O.G., and Longson, D.J., Ames Research Center, 1971.

(3) Effect of Facial Hair on Respirator Performance, American Industrial Hygiene Association Journal, Hyatt, E.C., Pritchard, J. A., Richards, C.P., and Geoffrion, L. A., Vol. 34, 1973.

(4) Effects of Facial Hair in Oxygen Masks, Naber, D. G., Report No. NADC-72211-CS, 1972.

(5) Investigation Into the Sealing Effect of Face Masks, Warncke, C., and Schipke W., Drager Review 38, 1976.

(6) Effect of Physical Activity of Airline Flight Attendants on Time of Useful Consciousness in a Rapid Decompression Busby, D.E., Higgins, E. A., and Funkhouse, G. E. Aviation Space Environment Medicine 47(2):117-120, 1976.

(7) Aircrew and Passenger Protective Breathing Equipment Studies deSteiguer, D., et. al., FAA Office of Aviation Medicine 78-4.

4. BACKGROUND. Researchers at the Federal Aviation Administration's Protection and Survival Laboratory located at CAMI have investigated the effects of beards on oxygen mask performance. This research was prompted, in part, by previous investigations which reported possible problems with oxygen mask efficiency when used by bearded persons.

5. DISCUSSION.

a. Several investigators had reported that the presence of beards caused a decrement in the efficiency on half masks, full masks, and respirators. A Department of Navy study (No. NADC-72211-CS) reported an average inboard leakage of 16 to 67 percent for military-type crew oxygen masks when tested with subjects wearing beards to altitudes of 18,000 feet. Civilian crew oxygen masks vary considerably from these types of masks because of differences in basic mask designs, suspension systems, and controlling regulators. Consequently, CAMI conducted research to determine if the problems noted in these reports would also be present when civil aviation oxygen equipment was tested.

b. During the CAMI research, three popular TSO-approved crewmember oxygen masks equipped with mask-mounted regulators were tested to determine if a decrement in performance would occur as a result of the presence of facial hair. The data resulting from these tests indicated that decrement in performance does occur when facial hair is present along the sealing surface of crew oxygen masks. This decrement is proportional to the amount of facial hair present, the type mask worn, the suspension system associated with the mask, and the exercise level to which the individual is subjected. This study, as well as studies conducted by the military and oxygen equipment manufacturers, concluded that respirator/oxygen (sometimes referred to as "demand") masks cannot be donned rapidly and do not seal over beards or heavy facial hair. This lack of a seal could result in a reduced amount of oxygen in the mask and the entry of smoke or toxic fumes that could result in reduced crewmember capability and performance.

c. CAMI investigators conducted additional research on the influence of beards on the efficiency of passenger (continuous flow) oxygen masks. Continuous flow masks are intended to provide protection from hypoxia in the event of a decompression. Three models of masks (two of which were

TSO-approved) were tested. The data indicated beards adversely affect the efficiency of continuous flow oxygen masks. The leakage of ambient air caused by beards does not permit an adequate percentage of oxygen to be presented to the lower portion of the respirator tract. The proper functioning of the continuous flow mask relies on having the greatest concentration of oxygen presented at the beginning of inspiration (taking a breath or inhaling) with dilution of oxygen permitted during the latter phase of inspiration. The concentration of oxygen and the inspiration phase during which it is inhaled are more critical factors than the total oxygen received. Bearded passengers might expect some deficit in oxygenation following a decompression that could lead to varying degrees of hypoxia (physiological conditions that result when the body does not receive enough oxygen). If the mask is properly donned and usual emergency descent procedures can be followed, the deficit in oxygenation might not be severe enough to be life-threatening, but could cause loss of consciousness.

d. Flight attendants are more physically active than passengers, and earlier studies conducted at CAMI demonstrated that physical activity representative of flight attendant duties reduces time of useful consciousness by about 40 percent over that of a resting individual. In addition, physical activity increases the respiratory exchange rate. Data collected in pertinent CAMI research indicate that bearded individuals with the highest respiratory exchange rate experienced the greatest degradation in oxygenation. Thus, the combination of the increase in respiratory exchange rate and decrease in efficiency of an oxygen mask when worn by a flight attendant could result in that individual being impaired in the performance of their assigned safety related duties.

6. CONCLUSION. Bearded crewmembers should be aware that oxygen mask efficiency is reduced by the presence of facial hair. Demand masks, such as those used in protective breathing equipment, many times cannot be donned rapidly nor seal effectively when used by bearded individuals. This can adversely affect the performance of the mask and reduce crewmember awareness, capability, and performance. Flight attendants should be aware that their job-related physical activity reduces time of useful consciousness and increases respiratory exchange rates. These factors, combined with the reduced efficiency of continuous flow oxygen masks associated with beards, could produce physiological symptoms that might reduce the flight attendant's ability to perform their safety related duties.

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