

Report SAM-TR-80-43

# FIELD STUDY DETERMINATION OF VENTILATORY REQUIREMENTS OF MEN RAPIDLY EVACUATING A SPACE LAUNCH COMPLEX

Loren G. Myhre, Ph.D.

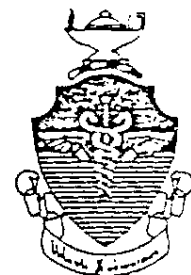
November 1980

Final Report for Period January 1980 - February 1980

SAL 000046263

Approved for public release; distribution unlimited.

USAF SCHOOL OF AEROSPACE MEDICINE  
Aerospace Medical Division (AFSC)  
Brooks Air Force Base, Texas 78235



UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

| REPORT DOCUMENTATION PAGE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                       | READ INSTRUCTIONS<br>BEFORE COMPLETING FORM                                            |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|----------------------------------------------------------------------------------------|
| 1. REPORT NUMBER<br>SAM-TR-80-43                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 2. GOVT ACCESSION NO. | 3. RECIPIENT'S CATALOG NUMBER                                                          |
| 4. TITLE (and Subtitle)<br>FIELD STUDY DETERMINATION OF VENTILATORY<br>REQUIREMENTS OF MEN RAPIDLY EVACUATING A<br>SPACE LAUNCH COMPLEX                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                       | 5. TYPE OF REPORT & PERIOD COVERED<br>Final Report<br>Jan 1980 - Feb 1980              |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                       | 6. PERFORMING ORG. REPORT NUMBER                                                       |
| 7. AUTHOR(s)<br>Loren G. Myhre, Ph.D.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                       | 8. CONTRACT OR GRANT NUMBER(s)                                                         |
| 9. PERFORMING ORGANIZATION NAME AND ADDRESS<br>USAF School of Aerospace Medicine (VNT)<br>Aerospace Medical Division (AFSC)<br>Brooks Air Force Base, Texas 78235                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                       | 10. PROGRAM ELEMENT, PROJECT, TASK<br>AREA & WORK UNIT NUMBERS<br>62202F<br>7930-14-06 |
| 11. CONTROLLING OFFICE NAME AND ADDRESS<br>USAF School of Aerospace Medicine (VNT)<br>Aerospace Medical Division (AFSC)<br>Brooks Air Force Base, Texas 78235                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                       | 12. REPORT DATE<br>November 1980                                                       |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                       | 13. NUMBER OF PAGES<br>21                                                              |
| 14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                       | 15. SECURITY CLASS. (of this report)<br><br>UNCLASSIFIED                               |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                       | 15a. DECLASSIFICATION/DOWNGRADING<br>SCHEDULE                                          |
| 16. DISTRIBUTION STATEMENT (of this Report)<br><br>Approved for public release; distribution unlimited.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                       |                                                                                        |
| 17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                       |                                                                                        |
| 18. SUPPLEMENTARY NOTES                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                       |                                                                                        |
| 19. KEY WORDS (Continue on reverse side if necessary and identify by block number)<br>Work Stress                      Self-contained Breathing Apparatus<br>Descending Stairs              Escape Device<br>Physiological Effects          Hypoxia<br>Heart Rate                      Hazards                                                                                                                                                                                                                                                                                                                                                  |                       |                                                                                        |
| 20. ABSTRACT (Continue on reverse side if necessary and identify by block number)<br>Physiological variables, including heart rate and minute ventilation, were monitored for 3 men and 1 woman during field trials simulating the emergency evacuation of Space Launch Complexes (SLC) 4E and 4W at Vandenberg AFB in January 1980. Rapid evacuation from the highest work level of SLC-4E to a designated point of safety (tunnel), unencumbered by the wearing of a respiratory protection device, could be accomplished in about 3 min. Monitored heart rates for 3 men, calculated at 30-sec intervals, averaged 145 bpm; peak heart rates |                       |                                                                                        |

SAL 000046264

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)

20. ABSTRACT (continued)

averaging 166 bpm occurred during the last min of the exercise. Ventilatory requirements for this rate of work, estimated to represent approximately 65% of the men's aerobic capacity, were estimated to average approximately 51 liters/min. Subsequent trials repeating the same rapid evacuation while wearing the currently approved Robertshaw Air Capsule were achieved with considerable difficulty, producing situations that could seriously compromise the wearer's safety. Most obvious hazards imposed by the air capsule included (1) almost total obstruction (fogging) of forward and downward vision, (2) the early onset and progressive severity of dizziness, allegedly the result of hypoxia, (3) the total collapsing of the air capsule around the head and face with each inspiration, and (4) the absence of an anti-suffocation device which would allow entry of outside air into the air capsule when the air reservoir becomes exhausted. However, the user is indeed cautioned to walk when wearing the Robertshaw Air Capsule, and there were no major complaints during evacuation from the SLC when it was used in this manner. Time required to accomplish a walking evacuation averaged 4 min, 19 sec; total air supply to the air capsule averaged about 4 min, 54 sec for the 5 units tested. It should be noted that although present regulations and directives state that workers should walk, not hurry down the SLC tower stairway and into the tunnel, such a disciplined evacuation in an emergency situation may be merely academic.

It was concluded that a reasonably fit adult male rapidly evacuating the SLC works at a load approximating 65% of his aerobic capacity. Associated with this level of work is a ventilatory requirement of about 51 liters/min with corresponding peak inspiratory flow rates predicted to average about 180 liters/min. Under these conditions excessive rebreathing of expired air with the concomitant onset of hypoxia was clearly evident when wearing the Robertshaw Air Capsule which delivers air at a rate of 25 liters/min. The Robertshaw Air Capsule is deemed to be unsuitable as a respiratory protection device during rapid evacuation of the SLC; its limited air supply (about 5 min) renders it a marginal device for a walking evacuation which requires about 4 min, 19 sec. The degree of protection from airborne contaminants provided by the Robertshaw Air Capsule under work stress conditions simulating both (a) rapid and (b) walking evacuation awaits laboratory testing.

SAL 000046265